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NUEXCO

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Monthly Report
on the
Nuclear Fuel Market

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EXECUTIVE SUMMARY
REPORT 183
(All data as of October 31, 1983)

Exchange Value
\$23.50, down \$0.50

The **Exchange Value** is **\$23.50** per pound U_3O_8, down \$0.50 since last month, the first decline in fourteen months. Three uranium sales transactions are reported, involving approximately 275 thousand pounds U_3O_8 *equivalent*. Two transactions involved enriched UF_6 and one involved concentrates.

Supply-Demand Ratio
rose slightly to 1.9:1

Active spot and near-term **uranium supply** amounts to **5.9** million pounds U_3O_8 *equivalent*, down 1.3 million pounds from last month. **Active** spot and near-term **uranium demand** fell 1.3 million pounds, to **3.1** million pounds U_3O_8 equivalent. Therefore, the spot and near-term **supply-demand ratio** rose slightly to **1.9:1**.

Transaction Value
unchanged at \$23.65

The **Transaction Value** is **\$23.65** per pound U_3O_8. It includes 21 transactions involving a total of 2.0 million pounds equivalent U_3O_8 and covers a period of six months.

Loan Use Charge Rate
unchanged at 6%

The **Loan Use Charge Rate** is **6 percent** per annum. No loans are reported.

Conversion Value
decreased to \$0.60

The **Conversion Value** is **\$0.60** per pound U as UF_6, down \$0.40 since last month. One secondary market conversion transaction is reported, involving 101-300 thousand pounds U as UF_6.

SWU Values
\$115 for DOE origin (FY84);
\$85 for non-DOE origin
(delivery within 15 months)

The SWU Values are **\$115 per SWU of DOE origin and \$85 per SWU of non-DOE origin.** The two SWU Values reflect the development of a two-tiered market as a result of DOE's modification of its Interim Sales Contract (ISC) offer. However, the market is still in a state of flux; this month's SWU Values were based on sellers' offers in the absence of transactions under the current altered market conditions. Spot and near-term demand for secondary market enrichment services amounts to 600 thousand SWUs; spot and near-term supply amounts to 1.1 million SWUs. This issue reports four secondary market SWU sales, involving a total of approximately 400 thousand SWUs.

Enrichment

This issue analyzes the commercial impact of DOE's modified ISC offer to holders of 3.5-year Requirements contracts.

Australia

The Prime Minister and his Cabinet are proposing a compromise policy for uranium mining and export, and environmentalists have won a preliminary victory that further threatens the Jabiluka project.

Japan

A recent government analysis of costs for alternate electricity sources shows that nuclear power has clear long-term advantages and will retain them as long as capital costs are controlled. Tohuku Electric Power's Onagawa Unit 1 has reached criticality thirteen years after a construction permit was granted.

South Africa

South Africa continues to be a reliable source of uranium, producing 3.9 million pounds U_3O_8 in the third quarter of 1983, almost exactly as much as in the second quarter of this year.

United States

Nuexco has revised upwards its forecast of US uranium production for 1983, but still anticipates 1984 to be a year of dwindling capacity.

Essay

Since the inception of the nuclear fuel market, the focus of its activity has shifted from the primary markets to the secondary markets for uranium concentrates and fuel cycle services. The natural course of events would lead to a return to emphasis on the primary markets if the secondary markets were allowed to function unimpeded.

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NUEXCO REPORT 183
FIGURES OF THE MONTH
(October 31, 1983)

	This Month (Report 183)	Last Month (Report 182)	12 Months Ago (Report 171)
Exchange Value[1]	23.50	24.00	17.50
Transaction Value[1]	23.65	23.65	17.00
Conversion Value[2]	0.60	1.00	1.60
Loan Use Charge Rate[3]	6%	6%	6%
Near-Term Uranium Supply[4]	5.9	7.2	4.3
Near-Term Uranium Demand[5]	3.1	4.4	2.1
Near-Term Supply-Demand Ratio	1.9	1.7	2.1
Recent Uranium Sales:			
Number of Transactions[6]	3	2	9
Quantity of Material[7]	0.1-0.3	0.1-0.35	1.4-3.0
Nuexco SWU Values:[8]			
DOE origin, FY 84 delivery	115	see note 11	—
non-DOE origin, delivery within 15 months	85		
USDOE SWU Prices:			
AFC	138.65	138.65	138.65
Requirements	149.85	149.85	149.85
Market Value of Enriched UF_6[9] [10]:			
2.5 w/o U_{235}	653.63	582.75	668.30
3.0 w/o U_{235}	838.93	743.24	865.68
3.5 w/o U_{235}	1,027.67	906.32	1,067.20
4.0 w/o U_{235}	1,218.95	1,071.62	1,271.79

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[1] US $ per pound U_3O_8 equivalent.

[2] US $ per pound U as UF_6.

[3] Per annum.

[4] Active inquiries to sell, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[5] Active inquiries to purchase, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[6] Uranium sales only; does not include loans, conversion, or SWU transactions.

[7] Millions of pounds U_3O_8, equivalent.

[8] US $ per SWU.

[9] Calculated using the Nuexco Exchange Value, Conversion Value, and 0.20 percent tails assay. Calculations before 2/28/83 used the USDOE price for AFC SWUs. From 2/28/83 through 9/30/83, calculations used the Nuexco SWU Value for the relevant fiscal year. As of 10/31/83, calculations use the SWU value for DOE origin and FY 84 delivery.

[10] US $ per KgU as UF_6.

[11] SWU Values for 10/31/83 were the first to distinguish between origins, so prior SWU Values are not comparable.

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THE FUELISH CYCLE:
MARKETS FOR EXCESS FRONT-END MATERIALS

By

George White, Jr.
President
Nuexco

Presented To:

Atomic Industrial Forum
Uranium Seminar

Santa Fe, New Mexico
October 6, 1983

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THE FUELISH CYCLE: MARKETS FOR EXCESS FRONT-END MATERIALS

By: George White, Jr.
President
Nuexco

Introduction

The title of this paper is not meant to be flippant. I will be discussing the markets for excess materials and services in the front end of the nuclear fuel cycle. These markets, namely uranium and its related services, conversion and enrichment, have been driven by near-term perceptions which have not always been accurate, and, in fact, have often been dead wrong.

My comments today may appear unduly bearish. My position is somewhat contrary to the optimism that seems to be spreading. That is because I believe it is healthy to sound a cautionary note at a time when optimism is the order of the day. I'm cautiously optimistic about the long term. I'm just plain cautious about the near term.

I want to cover four areas today. Where are we now? How did we get there? Where are we headed? And, finally, the particular role of the spot and secondary markets.

Where Are We Now?

Things are not as bad as they were a year ago, but the front end markets remain under considerable strain. Excess capacity exists in all segments. Economics aside, the World Outside Centrally Planned Economic Areas (WOCA) currently has the annual capability:

1. to produce more than 140 million pounds U_3O_8;
2. to convert more than 140 million pounds U_3O_8 into 54.5 million kgs U in UF_6;
3. to enrich, using nearly 40 million SWUs, more than 160 million pounds U_3O_8 into 3.0 percent enriched product, assuming a 0.25 percent tails assay.

By way of comparison, Nuexco's forecast of 1983 WOCA uranium consumption is 80 million pounds U_3O_8. And our consumption forecast for 1995 is only 130 million pounds. To be sure, some existing uranium mines will be exhausted before 1995, but many would-be producers are waiting in the wings.

Not only is there excess capacity, actual production also exceeds consumption. This statement is true with respect to uranium for every single year since the dawn of the nuclear age. In 1982, WOCA uranium production was 107 million pounds U_3O_8; consumption was only 63 million pounds. In 1983, the Nuexco forecast calls for production to drop to 95 million pounds U_3O_8, and, as noted above, consumption will increase to 80 million pounds. This gives rise to hopes that production and consumption are finally being brought into balance. However, Nuexco forecasts for 1984 and 1985 suggest otherwise. Production for those two years will be 95 million and 104 million pounds U_3O_8 respectively, while consumption will be only 83 million and 87 million pounds. Annual additions to inventory will continue, albeit at reduced rates, but these gross figures don't tell the full story, for a good deal of this material is being delivered to buyers who don't need it and who have little choice but to resell it.

The obvious outcome is, of course, excess and continued growth of inventory. Much of this inventory was and is held by those who can least afford to hold it or who have the least need for it. Cancellations and deferrals of nuclear projects and high interest rates led to inventory liquidation, a condition which has dominated the market since 1981. Uranium spot prices went from more than $40.00 per pound U_3O_8 to $17.00 before rebounding to $24.00. Secondary market conversion prices in the United States are but a third of prices in the primary market. Secondary market SWU prices plunged first to the $102 to $107 range and then lower after DOE announced its Interim Sales Contract. The uncertain success of the ISC and the unknown terms of the promised, but as yet unseen, Utility Services enrichment contract have left the SWU market confused.

None of the above is particularly new news to this audience. Depending on your particular interests, you may like or dislike the current situation, but your particular wishes and desires are largely immaterial. The market has a mind of its own. It doesn't much care what you or I individually may think about it.

How Did We Get There?

Initially there was the incredible optimism that rippled through the utility industry worldwide in the late 1960s and early 1970s. From the largest national utilities in the industrialized West to small, Third World countries, everyone was going to go nuclear. In the diverse U.S. market, the range was equally great, with the likes of a Commonwealth Edison, Duke and TVA at one extreme and small public power districts at the other. Electric usage was growing at 7% annually. Capacity had to double every 10 years. The oil embargo provided additional impetus. It is difficult to recall accurately the full extent of the enthusiasm. We were headed towards a nuclear Valhalla.

In response, the industry's infrastructure began to develop to meet the enormous demands for materials and

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services associated with this dramatic growth business. Thus, in the mid-1970s, DOE closed its order book, concerned about having adequate enrichment capacity; warnings were heard about a possible shortage of conversion capacity; uranium prices surged as buyers rushed to get theirs before it was all gone. In 1975, it was predicted that, by 1985, US uranium consumption alone would exceed 100 million pounds U_3O_8 annually. I distinctly remember this concern and the specific comment: "Just think, every year we must find and put into production a new Mt. Taylor." Thus developed the overcapacity and the attendant overproduction that plague the industry to this day.

Now, with the advantage of 20-20 hindsight, we can observe the Three Mile Island incident as a watershed event. I don't believe that TMI, in and of itself, caused anything to happen that would not have happened of its own accord in time. Indeed, high interest rates, escalating costs, regulatory delays and, above all, low growth rates had set the stage for a structural change in the nuclear industry. And, while delays and cancellations had occurred prior to March 1979, it is now clear that Three Mile Island caught the attention of people in the executive suites as had no previous event. It focused concerns and catalyzed action. A trickle of deferrals and cancellations became a flood. Large nuclear utilities became small nuclear utilities, and small nuclear utilities packed it up completely.

The fuel markets, of course, felt the full brunt of these decisions as excess inventories were liquidated. Uranium prices broke sharply lower, and discounted secondary markets developed for conversion and SWU. Hardly a surprising development, as non-nuclear utilities have little need for U_3O_8, conversion, or SWUs.

And everyone missed the early warning signs. When I say everyone, I mean all of us—utilities, producers, converters, enrichers, consultants *and* brokers. The handwriting was on the wall, but we refused to see it primarily because we didn't want to. However, and this acknowledgement is long overdue, there was one individual who called the tune with uncanny accuracy years before any of the rest of us. I refer to Vince Taylor of Pan Heuristics. He was much maligned within the industry at that time, but his two papers "The Myth of Uranium Scarcity" published in April 1977 and "How the U.S. Government Created the Uranium Crisis (and the Coming Uranium Bust)" published in June 1977 make very interesting reading today.

Where Are We Headed?

Excess capacity, excess production and large inventories which continue to grow lead me inescapably to the conclusion that spot prices will, at best, be volatile with buyers dominant, until the previously cited conditions are attenuated. I find it difficult to develop a convincing case for any substantial or sustainable price recovery while production continues to exceed consumption and substantial inventories are held in weak hands.

Enormous quantities of inventory have been liquidated since 1981. But equally large quantities have yet to be moved. There are numerous situations in which large inventory holders are suffering financial distress and/or have badly lagging nuclear programs. A particularly disturbing aspect of these situations is that inventories tend to be increasing at those very utilities which have the least need and can least afford it. They cannot be expected to hold it indefinitely. Common sense and economics demand its sale, as will regulators and rate payers. Inventory in weak hands makes for unpredictable markets. A sustainable upward movement in spot uranium prices and real recovery of the secondary conversion and SWU prices must await the redistribution of these excesses. The sixty-four dollar question is, of course, how long will all this take. I cannot foresee the future any better than any of you, but I doubt that we can accomplish what needs yet to be done in less than 12 months.

In my opinion, prices in these markets will continue to follow cycles even if and when the current imbalances are corrected. I recognize this may be contrary to the conventional wisdom and certainly contrary to current industry sentiment, which might be characterized something like this: "Once we manage to work off this damned inventory and bring supply and consumption into rough equilibrium we can all proceed on a more business-like basis."

I don't wish to suggest boom and bust cycles of the duration and severity experienced in uranium (i.e. $6 to $43 to $17), but periodic cycles nevertheless. My reasons are two. First is the nature of the basic utility charter; namely, reliable service at the lowest possible cost consistent with regulated rates of return sufficient to attract investment capital. Utilities are risk averse, and risk aversion translates into policies of conservatism. Too much too soon may not be desirable, but is infinitely preferable to too little or too late. A too much/too soon policy will, in aggregate, over time, dictate excess productive capacity being put in place earlier than required, be it uranium, conversion or enrichment. This will be followed, in turn, by liquidation, price weakness, diminution of capital investment, contraction, and finally by new concerns about future shortages, and higher prices as the cycle repeats.

Second, there is the sole-use-nature of uranium and its related fuel cycle services. Nuclear plants cannot be fueled with anything other than uranium. Coal, gas and oil are relatively interchangeable, and substitution does

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take place as prices change, just as happens in metal markets. Such is not the case for the nuclear fuel cycle.

I do not intend by these remarks to blame the utilities for anything. I appreciate their conservatism, and view the results as a necessary, even a desirable condition of their existence. I like cheap electricity, but I prefer expensive electricity to none at all.

A third general observation relates to the international nature of the market. The nuclear fuel business started in the international arena with the United States buying uranium from Australia, Canada and the Belgian Congo and with AEC as the monopoly supplier of enrichment services worldwide. But these and similar situations were characterized by large entities, usually governments, dealing on a large quantity, long-term basis. Recently we have seen individual utilities and other entities wheeling and dealing worldwide in the spot and secondary markets—wherever they can find some slight advantage. To me this reflects the growing sophistication and experience of fuel managers. I anticipate a continuing increase in international nuclear fuel commerce. This increase will occur in spite of ill-conceived attempts by governments to regulate you, *and,* perish the thought, to protect you and help you.

Some Specific Thoughts on the Future

With respect to the uranium market, it is increasingly the conventional wisdom that prices are moving up and will continue to do so. Those of you who have heard me speak before may recall that I tend to suspect conventional wisdom and look for reasons to take a contrary view. As the consensus of experts grows concerning the likely occurrence of some future event, so does my suspicion that the event in question will not occur. Personally, I remain concerned about overhanging inventories—held by producers and utilities alike. To be sure, much of this inventory is in the wrong form, or in the wrong place, or of the wrong origin, but these are all problems that can be solved with money. I'm not saying prices won't rise, for in the longer term they probably will. But I do say the market will remain extremely vulnerable to short-term price swings until more of that inventory finds its way into stronger hands.

The preceding comment is, of course, in the main directed to the spot market. However, as history has shown and despite protests by buyers and sellers alike, long-term uranium prices are influenced by spot prices. Consider this fact: three or four years ago long-term negotiated prices were in the range of $43 to $45 per pound U_3O_8; today long-term negotiated prices under these same contracts are in the range of $33-$35—a 30 percent reduction, even before one considers inflation. And the Euratom Supply Agency average price for deliveries under medium and long-term contracts has declined from $36.00 per pound U_3O_8 in 1980 to $33.25 in 1981 and to $32.00 in 1982.

With respect to the conversion market, the situation is equally serious. Unlike the uranium market, most utilities already have intermediate or long-term contracts in place. Near-term supply swamps near-term demand. The level of secondary market conversion prices, about one third that of primary market prices, testifies to the imbalance. It is not inconceivable that the secondary conversion prices could temporarily go to zero, or even to a negative value, as UF_6 sellers attempt to force sales to buyers who need U_3O_8. This suggests the possibility of contract cancellations and/or renegotiations. Ultimately, of course, the best home for excess conversion is the converters themselves. This, in turn, would suggest production cutbacks sufficient to absorb the excess. The unique character of this market suggests that its recovery could lag that of the uranium market.

With respect to the SWU market, we have an even more interesting situation. First, DOE touted the Facility Requirements (FR) contract as the vehicle both to regain its competitive position in the world enrichment scene and to reduce the build-up of future SWU inventory. However, after a much criticized first draft, the FR contract never really saw the light of day. Secondary market activity increased, predicated on aggressive sellers with growing inventories of excess SWUs and the ability to create buyers through partial terminations under DOE's 3.5-year requirements contract. DOE grew increasingly restive about its loss of business to this secondary market, and frantic when such losses were to non-DOE sellers. The monopoly was being impaired.

With the avowed intention of restoring its monopoly position and closing off the secondary market, DOE, in late July, announced a quick fix for fiscal years 83, 84 and 85—the Interim Sales Contract or "mini deal," which essentially lowered the breakeven price by $11.20 per SWU. Reaction was swift. Secondary market sellers dropped their prices to create new incentive, with the specific intention of demonstrating that a secondary market would continue to exist and that, consequently, the 3.5-year holders shouldn't accept the mini-deal.

It is, however, premature to offer a final verdict on the mini-deal. While some utilities have accepted it and some are reportedly ready to accept, others have indicated they will not accept. On the other hand, certain things are clear: secondary market prices have been driven sharply lower; there is spirited competition between sellers at

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these lower levels; and prices are approaching the level where 5-year requirements contracts could come into jeopardy, notwithstanding their higher termination charges.

The next step in the DOE campaign is expected to be the Utility Services enrichment contract (USEC). Its terms and conditions are reportedly designed to motivate conversion by the 3.5-year requirements contract holders, removing them as buyers of secondary market SWUs. Lacking access to the specifics, it is impossible to comment further at this time. I would judge, however, that it will be very difficult for DOE, or anyone else for that matter, to make the secondary market go away. The 3.5-year requirements contract is enormously attractive. It is very flexible. It provides unique access to a world awash in SWUs and aggressive sellers trying to dispose of their excesses. Why would a utility willingly cut itself off from such possibilities and give up such flexibility? As a utility, I can think of no better situation than being one of the few holders, and preferably the last holder, of 3.5-year requirements contracts.

Spot and Secondary Markets

At the outset, I would comment on certain characteristics of the markets for uranium, conversion and enrichment. Primary and secondary markets exist for each. For our purposes, I define a primary market as one in which the entity producing the product or service is the seller. This would include uranium producers, converters and enrichers. Similarly, I define a secondary market as one in which the end user becomes the seller, usually with the intent of disposing of excess product or services.

In this regard, the conversion and SWU markets are reasonably alike: the primary market is characterized by suppliers dealing with customers on an intermediate to long-term basis; price levels are either public information or generally known; suppliers do not compete at secondary market price levels; each market is characterized by a small group of sellers—with only five WOCA converters and only three WOCA enrichers. Finally, the secondary markets for conversion and SWU are true secondary markets, with end users dealing exclusively with other end users. To date, the suppliers have not appeared in the secondary market as either buyers or sellers.

Compare this situation with that found in the uranium market. Indeed there is a primary market characterized by uranium producers with large reserves dealing with end users on a long-term basis. But while some average prices are published, there is no defined, universally accepted long-term price. And in the markets for spot and near-term delivery, primary and secondary activity is so interwoven that the markets are indistinguishable. Primary suppliers appear as both buyers and sellers, sometimes even on the same day, as do end users. Production is reduced or terminated in favor of open market purchases when economics dictate. Thus, this market has come to be called simply the spot market—even though it often includes transactions for near term and even intermediate term delivery. More importantly, however, and unlike the conversion and SWU markets, the spot price for uranium has had substantial and direct effects in two areas: first, it affects the annual price negotiations under long-term contracts with provisions for such negotiations; and second, it influences the price obtainable in new contracts at any given point in time.

Another important attribute of the spot and secondary markets is their visibility. One has only to pick up the most recent edition of *Nuclear Fuel*. Only for these markets are regular price series published. Nuexco and its worthy competitors are often criticized for our participation in and reporting on the spot and secondary markets. The reporting of uranium prices and secondary market conversion and SWU prices is viewed as destructive by producers if, in their view, prices are too low, and viewed as destructive by utilities if they believe prices are too high. Today, of course, many producers are unhappy. Such prices are not seen as indicative of the cost of producing uranium, conversion or SWU, nor indicative of the true value of these items, nor indicative of the current long-term contract price, nor indicative of the price necessary to sustain the industry over time.

All the above is true. Spot and secondary markets don't have to meet these tests. You may like the spot price or hate it—but that won't change it. The fact of the matter is that if you go out to buy or sell uranium for spot or near-term delivery, you know and I know the price is going to be somewhere near Nuexco's Exchange Value or Nukem's quote. And, if you elect to deal in the secondary market for conversion or SWUs, you will achieve similar results. Even if all the brokers and consultants were to disappear overnight, the spot market and secondary market would continue to exist. These markets were not invented by brokers; they developed because of the need to redress imbalances in the marketplace.

As DOE grew increasingly and vocally concerned about the secondary market, references were made to the avalanche of secondary market SWUs, the need for a "rational" market and the need to dry up the secondary market. Where did the avalanche come from? Each and every SWU was a primary market SWU before it became a secondary market SWU. How does one make a secondary market go away? Since increased consumption can-

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not be mandated, the answer seems obvious—production should be reduced. The only other alternative is to force SWUs on customers who neither need nor want them—which action increases utility costs and, of course, fuels the secondary market.

It is interesting in the face of the need to correct the current imbalances that some primary producers of uranium, conversion and SWUs, and particularly the SWU producers, view the secondary market as an amoral creation. They appear to resist the view that these markets are the result of the free market in action, and are an essential activity to effect the required redistribution of excess material and services. Much of today's market turbulence might well have been avoided had these markets functioned earlier and more actively.

The increased efficiency of these markets has led to an uncomfortable situation for primary suppliers. The ability of end users to acquire material and services in the secondary and spot markets, at what are viewed as bargain prices, has allowed end users to defer contracts, cash flow and earnings for the primary suppliers. Moreover, the large quantities available allow end users to acquire base load from spot and secondary sources, as opposed to using these sources merely to top off and fine tune their needs. Thus, we see end users utilizing these markets to purchase entire first cores, or reload batches on a regular year-by-year basis.

In some cases, these markets are used in place of more conventional longer-term purchases. When spot or secondary market prices are sufficiently below primary prices, it becomes more economical to buy and hold than to conclude the more conventional long-term contract. Simply stated, and depending on the current availability of cash, if today's price plus carrying costs is less than the estimated price to be paid at some future date, a spot or secondary market purchase may be judged more economical. While painful to primary suppliers in the short term, such purchases do result in clearing out the inventory overhang.

If weak secondary markets and weak spot markets result from the redistribution of excess goods and services, it would seem logical to eliminate the imbalance. Yet SWU contracts produce more SWUs than are consumed. Conversion contracts feed UF_6 to the SWU machines, and uranium producers deliver U_3O_8 to converters for conversion into UF_6. Since we know full well we cannot increase consumption, there seems but a single, simple answer. Perish the thought, we should rationalize the market by reducing production. Fortunately, we don't have to make such decisions. The spot and secondary markets will continue to force decisions. It is not unreasonable to believe that a uranium spot price of $17.00 had something to do with the sharp decrease in uranium production. Neither is it unreasonable to observe that the secondary SWU market has driven DOE to consider offering improved and more flexible enrichment contracting terms.

Finally, I would comment on one particular aspect of today's markets, and that is the creativity of transactions, particularly those in the secondary markets. Uranium producers, converters and enrichers must look beyond the supply/demand balance in their individual markets. If 29,200 kgs of 3.0 percent enriched product is involved in a de-enrichment/deconversion swap at a 0.30 percent tails assay, the resulting products include 100,000 SWUs, 192,000 kgs of conversion and 500,000 pounds U_3O_8. Such transactions are becoming industry standard, and serve to tighten the interrelationships in the front end of the fuel cycle. Thus, uranium producers and converters need to watch and understand the enrichment scene, and uranium producers need to be aware of the conversion situation. As if this were not enough, let me suggest another step. We have deconversion, and we have de-enrichment; have you considered defabrication? It is, in fact, being considered.

In conclusion and because naming names is bad form, I must take note of that friendly, fictitious electric utility company, North-South Public Service, which has recently become a non-nuclear utility. Does anyone in this room seriously believe that North-South Public Service should be purchasing uranium to feed its conversion contract to provide UF_6 to meet its enrichment obligations for a now, nonexistent plant? I certainly hope not. But if there are some here who do believe that, let me say only this—Welcome to the Fuelish Cycle.

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NUEXCO

ANOTHER COMEBACK FOR URANIUM

By

Thomas A. Boyden
Vice President
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Presented By:

Donald W. Radcliffe
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Presented To:

Society of Petroleum Engineers of AIME
58th Annual Technical Conference and Exhibition

San Francisco, California
October 5-8, 1983

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NUEXCO

ANOTHER COMEBACK FOR URANIUM

By: Thomas A. Boyden
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Abstract

The uranium market has been unstable since private industry entered the nuclear power generating business in the early 1960s. Uranium supply has always exceeded demand throughout the Free World. In 1982, production was 106 million pounds U_3O_8 and accumulated inventory totaled over 400 million pounds; consumption was only 63 million pounds. Recent inventory selling, production cutbacks and producers buying from consumers, have led to decreasing prices and further market instability.

It now appears that the market is beginning to change to a more stable situation. Current forecasts indicate that Free World demand will almost double by 1996, led by Europe and the US. Annual production will average about 110 million pounds during the same period. A closer balance between supply and demand should allow market prices to improve between now and 1990.

The situation in the US is more complex. Consumption will increase to 39 million pounds through the 1990s while annual production is expected to decrease to about 12 million pounds (down from a 1980 high of almost 44 million pounds), before higher prices allow extended recovery to an annual production level of about 22 million pounds. The balance of US consumption will be met with imports and inventory drawdowns. Higher prices in the latter part of the decade will support a number of new solution mining projects, and allow the development of high-grade ore deposits by conventional methods. The US producer industry will survive, but will be secondary to those in Canada, South Africa and probably Australia.

Introduction

Uranium is a unique mineral. It has only one industrial use. It is the principal fuel commodity for nuclear power. Every industrial nation and many developing nations already have nuclear power installations, or are presently considering it as a future power source. Even so, the nuclear power industry has not developed as earlier expected throughout the Free World. The growth rate of the industry slowed sharply in response to a sagging world economy and a sharp decline of industrial power demand. The future of the industry remains uncertain, even as economic recovery seems close at hand.

Another comeback for uranium implies that the uranium production industry will recover with new mines starting up and old production centers returning to full work schedules. The recovery will not be that strong. Presently, the industry is suffering from excess productive capacity, excess production, increasing inventories and low prices.

Nuclear Power Growth

Further development of the uranium supply industry is dependent on continued expansion of nuclear power generation. Nuclear generating capacity is expected to increase from 146 gigawatts (GWe) as of 1982 to approximately 360 GWe in 1996. This is a compound increase of about seven percent per year, compared to long-term electrical load growth estimated at 2.8 percent per year.

The 1982 capacity of 146 GWe was generated by 199 operating plants in 23 countries and 78 operating plants in the United States. The expansion to 360 GWe by 1996 is projected on the successful completion and operation of 175 plants now under construction outside the US and 59 plants in the US.

Nuclear generating capacity will increase in the US from the installed 58 GWe in 1982 to about 111 GWe by 1992. Further growth will not occur because additional plant orders are not expected before 1990. Plant lead time is presently 12 to 14 years, but this could decrease to 8 or 10 years by the end of the decade if licensing schedules are streamlined. Nuclear generating capacity in the US may not show further increase prior to the year 2000.

Nuclear power offers considerably greater economic advantage in Europe and the Far East than in the US. Coal in Britain and Germany represents the only indigenous energy resource available in Europe. Other substantial resources and alternate power sources are too expensive throughout Europe and the Far East. Regardless, only two countries currently have sustained nuclear programs, France and Japan. France has the most aggressive building program, presently at 24 GWe and increasing to almost 63 GWe by 1996. Nuclear capacity may comprise 60 percent of France's electric generating capacity by that time. By comparison, nuclear capacity in the US will represent only 15 percent or less of total generating capacity by 1996.

Japan is totally dependent on imported energy resources. The disruption of oil deliveries in the early 1970s created new incentives for Japan to diversify its electric power base. The Japanese are converting oil-fired plants to coal and LNG, and are building new coal, LNG, hydro and nuclear plants. Japanese nuclear power capacity of

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17 GWe in 1982 is projected to increase to 46 GWe by 1996.

The amount of installed electric capacity in West Germany is among the largest in Europe. It was developed over the years to support Germany's large industrial base. However, the nuclear power program has been affected adversely by regulatory and licensing problems. The immediate need for nuclear power was postponed as a result of long-term development of low-grade coal resources and more recently, the availability of North Sea oil. Now, nuclear power appears to be the only remaining alternative for sustaining industrialization. The German nuclear program is gradually moving forward. It is expected to more than triple from the 1982 level of 10 GWe to approximately 36 GWe by 1996.

It is generally concluded that nuclear power programs throughout the rest of Europe and the Far East will continue to move forward, but on greatly diversified schedules. Spain and Italy are faced with curtailed programs due to political and plant siting problems, but both have plans to expand throughout the 1980s and 1990s. The construction program in Sweden is developing on a schedule to increase from the 1982 capacity of 6.8 GWe to 9.4 GWe in 1988. The current building program ends in 1888 and generating capacity remains at 9.4 GWe through 1996. Korea and Taiwan had aggressive construction programs which only recently were curtailed for economic reasons.

Programs in the United Kingdom and the United States appear to be less critical to the economic and industrial growth of each country. Both have large coal, oil and gas generating programs. However, each country had large nuclear construction programs underway prior to the "energy crisis" of the mid-1970s. The programs were cut back considerably by lack of electrical load growth due to energy conservation. Additional pressure of changing plant economics, and political and social delays resulted in the cancellation of many nuclear power plants. In the US alone, 101 plants have been canceled since 1975 (out of 251 plants ordered since 1955). The nuclear programs in both countries are being adjusted to changing demand patterns. Construction of new plants is progressing, but at a rather slow rate.

Uranium Consumption

Uranium consumption is a direct function of in-place nuclear generating capacity. It describes the amount of uranium processed annually for the operation of a reactor. Nuexco has analyzed consumption on a reactor-by-reactor basis for each country, with attention to internal economics, current energy consumption, national energy alternatives and related economics of nuclear power. Final analysis includes technical improvements in nuclear plant and fuel performance. Public opinion and politics are unpredictable factors that can have considerable influence on a particular nuclear program. The US is a case in point. Orders for new nuclear power plants have been postponed in several states by legislation based on the need for a demonstrated disposal method of spent nuclear fuel.

Free World consumption was 63 million pounds U_3O_8 in 1982. It is predicted by Nuexco to increase to 136 million pounds in 1996. The exponential growth rate for that period is about five percent per year.

United States consumption will increase from 21 million pounds in 1982 to about 35 million pounds in 1992, maintaining that level through 1996. If new plant orders are not forthcoming before the 1988-90 period, consumption will remain at 39 million pounds per year beyond the year 2000. The steady increase in consumption over the next six to eight years will outstrip US production. Consequently, US utilities will have to import uranium to satisfy requirements.

Inventory Position

Uranium consumption has always been less than supply. As a result, Free World inventories have been growing annually. Inventory is the commercial accumulation of uranium held by consumers. It is herein expressed as pounds of U_3O_8 equivalent, although it may be U_3O_8 concentrate, natural UF_6 or enriched UF_6.

The inventory imbalance is distributed among most users, but primarily those outside the US. Large inventories are held by France, Germany, United Kingdom and Japan. In fact, total Free World inventories in all stages of the fuel cycle are currently estimated at over 400 million pounds U_3O_8 equivalent, or about 5 years of forward consumption.

A survey by Nuexco indicates that, in general, utilities will not let inventories be drawn down to zero. Each would maintain a minimum forward inventory adjusted to future consumption schedules. It is assumed by Nuexco that minimum inventory levels will be maintained as follows: Europe, 3 years; Far East, 4 years; United States, 1.5 years.

As consumption increases and production levels off during the next few years, the Free World inventory situation will stabilize by about 1988 and then decline to the

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near desired levels by the 1994-96 period. The inventory position of the US should reach a normal mode by 1988.

The US held about 35 percent of Free World inventory in 1982. By Nuexco's estimate, that percentage will decline to about 13 percent by 1996. Inventories outside the US will peak about 1990 and gradually decline to the acceptable inventory level by the 1990-96 period.

Production

Uranium mines and mills currently in place throughout the Free World have the capacity to produce approximately 160 million pounds U_3O_8 annually. The figure has increased with the commissioning of the Key Lake mine and mill located in northern Saskatchewan. However, due to an annual oversupply situation, curtailment of production is expected in every major production center except Canada and South Africa.

Actual production during 1982 was 106 million pounds, down from 112 million in 1981. Production will be down to 95 million pounds in 1983. The decline can be attributed primarily to curtailment of US production since 1980. High-cost US producers are closing their facilities and are being displaced by inventory selling and lower cost production in Canada and elsewhere. Certain US producers have stopped producing in favor of buying low cost inventory material to fill higher priced delivery contracts. Not until inventory selling runs its course will consumers return to buying from producers.

Free World production originates from eight different countries. At the end of 1982, Australia produced 12 percent of world total, Canada 22 percent, Namibia 11 percent, Niger and Gabon 11 percent, South Africa 16 percent, the United States 16 percent, and all others including Europe 12 percent. By 1990, the US share of production will have decreased to about 13 percent and Canadian production will have increased to about 31 percent, almost entirely from northern Saskatchewan. Other market shares will be down slightly. South Africa will remain about the same.

The Producer Industry

The industry's response to nuclear power forecasts of the early 1970s resulted in overcapacity and overproduction. Later plant cancellations and construction deferrals added to an unpredictable situation. Utilities became sellers of excess uranium in direct competition with primary producers. Uranium prices declined sharply from \$40 per pound U_3O_8 in early 1980 to a low of \$17 by mid-1982. Many production centers curtailed activities or closed down facilities, primarily in the US.

Although the spot-price recovered to \$24.00 by September 1983, it remains well below the level required to justify most new production ventures or the reopening of shut-down properties. This is especially true in the US where the cost of production is no longer competitive with certain non-US producers. US production will drop below consumption for the first time this year. US utilities will be forced to import uranium to meet their requirements. Nuexco estimates that US utilities' unfilled requirements will increase annually from three million pounds in 1983 to over 30 million pounds by 1994.

The United States represents the largest market for intermediate and long-term unfilled requirements. The comeback of the uranium industry is tied to the unfilled requirements of the US. The Canadian industry will be the main beneficiary in filling a large part of the requirements. Certainly South Africa is in a favored position to benefit; the potential of other African nations is less certain. Australian uranium could be included but probably not before 1988 or 1990.

Acquiring large quantities of uranium from foreign producers is not without potential problems to US utilities. A seller may be subjected to a variety of economic, political and social circumstances that could limit or eliminate buyer interest. Canada, for instance, will allow uranium to be exported only in the form of UF_6. Certain US utilities take exception to this policy because they already have long-term conversion contracts with US converters.

The uranium producing nations in Africa are South Africa, Namibia, Niger and Gabon. Each nation could definitely be a seller to US utilities. In fact, a limited amount of South African material has already been sold in the US. However, each nation has complex political, social and economic problems. US buyers' attitudes are influenced by their internal policies as well as by outside pressure from political groups. Uranium purchases from the African nations will be limited for some US utilities.

Australia has the world's largest known uranium resources. The two operating mines have a combined production of 11 million pounds per year. None of that production is sold to US utilities. Development plans of other important deposits are currently caught up in unfavorable industry economics and the political opposition of the Labor Party. Those two problems will probably keep Australia out of the US market for at least the next five to ten years.

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Summary

US producers will supply about 15 percent of world uranium production and about 45 percent of domestic requirements well into the 1990s. US utilities will look to US producers as an assured source of supply. The industry will be restructured to consist of more small in situ leach projects and fewer underground mining operations. A few new producers will develop in situ leach mines in Wyoming, Texas and Nebraska. Also, one new open pit mine may start up in Virginia. US production will recover from the projected low of 12 million pounds U_3O_8 per year and expand over time to about 16 million pounds per year.

Uranium production will increase in Free World countries outside the US through expansion of existing projects and addition of new projects. US producers primarily will augment world production. It is doubtful, however, that the US production industry will ever again be as big as it was in the boom years.

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MONTHLY REPORT ON THE NUCLEAR FUEL MARKET

November 1983 No. 183

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To Our Readers

On October 21, Nuexco's chairman and chief executive officer, Mr. J. R. Wolcott, testified before the US House of Representatives Subcommittee on Energy Conservation and Power about the secondary market for enrichment services. A Special Report to be issued this month to Category I and II subscribers will include his testimony and excerpts from testimonies presented by the US Department of Energy and other witnesses.

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NATURAL URANIUM

The **Exchange Value** as of October 31, 1983 is **$23.50** per pound U_3O_8, down $0.50 since last month, marking the first drop in the Exchange Value in fourteen months. The *Current Market Data* section of this Report lists three uranium sales, involving approximately 275 thousand pounds equivalent U_3O_8. Two transactions involved enriched UF_6 and one involved concentrates.

Active spot and near-term uranium supply (U_3O_8 or natural UF_6 offered at competitive prices, terms and other conditions) totals **5.9 million** pounds equivalent U_3O_8. **Active spot and near-term demand** for natural uranium totals **3.1 million** pounds equivalent U_3O_8. Therefore, the spot and near-term **supply-demand ratio** rose slightly to **1.9:1.**

The **Transaction Value** as of October 31, 1983 is **$23.65** per pound equivalent U_3O_8, unchanged from last month. The current Transaction Value includes 21 transactions involving a total of 2.0 million pounds equivalent U_3O_8 and covers a period of six months.

The **Loan Use Charge Rate** as of October 31, 1983 is **6 percent** per annum, unchanged since last month in this moribund market segment.

* * *

This month's $0.50 fall in the Exchange Value came about as the result of sellers' efforts to stimulate buyer activity. Even in the face of offering prices being lowered for the first time in fourteen months, potential buyers remained hesitant to make commitments. Many potential buyers, lacking near-term needs, are content to wait for an exceptionally attractive opportunity. As the end of calendar year 1983 approaches, buying activity is likely to increase. For example, at press time, one fairly large transaction was in the final stages and, barring some unforeseen difficulties, will be included in next month's Report.

SECONDARY MARKET CONVERSION SERVICES

The **Conversion Value** as of October 31, 1983 is **$0.60** per pound U as UF_6, down $0.40 since last month. Even though sellers dropped their prices by large margins during October, buyers remained selective. *The Current Market Data* section lists one secondary market conversion transaction, involving 101-300 thousand pounds U. Active secondary market supply of conversion services for delivery within three years totals 5.3 million pounds U as UF_6, while the corresponding demand figure is 2.1 million pounds.

Secondary market prices for conversion have fallen in recent months as a reaction to the fact that demand is virtually all discretionary. On the other hand, much of the supply in this market segment is associated with U_3O_8 or enrichment transactions of great value. Sellers are less price sensitive to the conversion component of these larger transactions.

SECONDARY MARKET ENRICHMENT SERVICES

The most important development in the secondary SWU market during October was DOE's modification of its July 25, 1983 offer of the Interim Sales Contract (ISC). DOE's October 18 letter to holders of Requirements contracts containing 3.5-year termination provisions summarized the two significant points of the new contract form.

1. It allows the customer to obtain on the secondary market *without termination charges* up to 40 percent of requirements for FY84 (60 percent for FY85), provided that both buyer and seller certify in writing that the secondary market SWUs are of US origin.
2. Those accepting the modified ISC must agree to convert to the Utility Services enrichment contract (USEC) when offered, provided that its terms are "no less favorable than those in the customer's existing Requirements-type contract when considered in its entirety." DOE has also offered to modify the few existing ISCs in accordance with the latest offer.

The latest DOE move has two clear objectives:

1. To stop the purchase of non-DOE SWUs in the secondary market by 3.5-year Requirements contract holders;
2. To facilitate the secondary market sale of excess DOE-origin SWUs, primarily by holders of AFC contracts.

At press time, the secondary SWU market was still adjusting to DOE's action, but several *preliminary* observations are possible.

1. The requirement to convert to the still unrevealed USEC is making many customers hesitate to accept DOE's offer. Virtually all utilities for which the modified ISC is an option have deferred any decision until their legal departments complete a thorough review of the actual contract language, so as to determine how binding such a commitment might be.
2. Sellers' offering prices for non-DOE SWUs have dropped and those for DOE SWUs have risen. The

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differential between non-DOE and DOE-origin offering prices has increased to approximately $30. Thus, a two-tiered market has arisen.

3. Before DOE offered the modified ISC, the secondary SWU market had been characterized by a single class of potential buyers made up of those DOE customers holding 3.5-year Requirements contracts. Sellers of DOE SWUs competed directly with sellers of non-DOE SWUs for the buyers, which were free to buy SWUs of any origin. Now, every customer that accepts the modified ISC will add to the segmentation of secondary market SWU demand into two classes. One group of buyers will be able to accept only DOE SWUs. The other group of buyers, though theoretically able to accept SWUs of any origin, essentially will be forced to purchase non-DOE SWUs because of the high differential between the two prices.

4. DOE has said it will continue to offer both types of ISC, the original and the modified forms, so it is possible theoretically for the buyers to be split into three groups. Potential buyers that accept neither ISC, but that are able to purchase SWUs in excess of their cumulative ceilings, will also have different motivations, so even a fourth class of buyers is possible, in theory.

5. Prices for non-DOE SWUs are now so low on the secondary market that holders of 5-year Requirements contracts could very well find it worthwhile to terminate their DOE deliveries, pay the 40 percent termination charge, and buy non-DOE SWUs on the secondary market. Thus, DOE is considering making an ISC offer available to 5-year Requirements contract holders; if it does, that group could become split as well.

6. At present, the market seems to be heading toward some degree of fragmentation with respect to the buyer group. However, it is essential to note that estimates of the degree of fragmentation that will take place are based only on informed speculation, at best. The market has not yet sorted itself out. It is not clear how many—and more importantly, which—holders of 3.5-year Requirements contracts will accept either ISC. The degree of market acceptance of the ISC will determine the future character of the buyer-seller relationship in the secondary SWU market.

This month's Report contains two SWU Values, reflecting Nuexco's best judgment of the conditions necessary to conclude secondary market SWU transactions. The **non-DOE SWU Value** is **$85** per SWU, for delivery within approximately 15 months. The time period chosen is intentionally flexible to reflect the way in which sellers of non-DOE origin SWUs structure their offers to sell. The SWU Value for **DOE-origin SWUs** is **$115** per SWU. That value refers to delivery in FY84, again reflecting the way in which sellers structure their offers. Both values are referenced to a tails assay of 0.20 weight percent U_{235} (the transaction tails assay for the holders of Requirements contracts). Depending on the values assigned to U_3O_8 and conversion, the equivalent price at a tails assay of 0.30 percent might be $6-8 higher. In this context, the equivalent price is that which would yield an identical cost of enriched product.

Three points are important to consider regarding this month's SWU Values.

1. The values are based on seller's offering prices in the absence of bids and relevant transactions. That is not to say that the SWU Values were set at the lowest offer. Rather, Nuexco examined the available data on sellers' offers in conjunction with other information about the market—such as the likely response of the market to the modified ISC—and came to judgments of the prices at which transactions could take place. While the *Current Market Data* section lists four SWU transactions this month (total quantity approximately 400 thousand SWUs), all four were executed on the basis of market conditions prevailing before DOE's offer. Thus, they bear less relevance to the current SWU Values than they would have done otherwise.

2. The present uncertainty is especially relevant to the SWU Value for FY84 delivery of DOE-origin SWUs. It represents a more substantial departure from recent price levels than does the SWU Value for non-DOE origin. Specifically, the existence of a two-tiered market depends on acceptance of the modified ISC by approximately 25 percent or more of the utilities with eligible contracts. If utilities overwhelmingly reject the modified ISC, there will be little market for DOE SWUs at prices near $115, and market prices will not be two-tiered. If, on the other hand, large numbers of customers accept the original ISC and large numbers accept the modified ISC, a three-tiered market is possible.

3. The secondary market is still adjusting to this latest DOE attack on the sellers of non-DOE SWUs. As of October 31, active secondary market supply of enrichment services for delivery within one year came to 1.1 million SWUs, while the corresponding demand was 600 thousand SWUs. Dramatic shifts are possible in the next few months as the market sorts itself out in response to the altered competitive environment.

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THE MODIFIED INTERIM SALES CONTRACT: ANALYSIS OF ITS EFFECT ON SWU PRICES

Table 1 illustrates the *short-term* choices available to the 3.5-year Requirements contract holder that is considering the modified ISC. Purchasing SWUs of non-DOE origin in the secondary market for $90 (the prevailing price at the time DOE modified the ISC), the buyer would pay a net price of approximately $127.50 per SWU ($90 to seller plus approximately $37.50 per SWU to DOE for the usual 25 percent termination charge). Accepting the modified ISC and buying 40 percent of the desired quantity in the secondary market for $102 (the prevailing price for SWUs of DOE origin at the time DOE modified the ISC), the buyer would reduce its average cost to $124 per SWU, saving approximately $3.50 per SWU compared to the other available choice.

Table 1

POTENTIAL SAVINGS ASSOCIATED WITH MODIFIED ISC

	Quantity[1] (thousands of SWUs)	Price (U.S.$/ SWU)	Cost (U.S.$)
Normal Cost of SWUs for Requirements Contract Holders			
FY 84 Requirements	200	149.85	29,970,000
Option 1: Buy Non-DOE SWUs in Secondary Market			
Secondary Market Non-DOE SWUs	200	90	18,000,000
DOE Contract termination charges	200	37.46	7,492,500
TOTAL COST			25,492,500
Option 2: Accept Modified Interim Sales Contract			
Secondary Market DOE SWUs	80	102	8,160,000
ISC (same price as fixed commitment)	120	138.65	16,638,000
TOTAL COST			24,798,000
Option 1 - Option 2 = $694,500 = *$3.47* per SWU			

[1] For illustrative purposes, the table assumes a nominal quantity of 200,000 SWUs. Unit prices are independent of quantity.

In the example shown in Table 1, a price for non-DOE SWUs of $86.53 per SWU would have yielded the same average unit cost ($123.99) that the buyer would pay under Option 2 (accepting the revised ISC and buying 40 percent of FY84 requirements on the secondary market at $102 per SWU). Table 2 shows, for several different secondary market prices for DOE SWUs, the prices that theoretically would make buyers indifferent between the purchase of non-DOE SWUs and the purchase of DOE SWUs. The indifference prices do not include any provision for the amount of additional savings necessary to motivate buyers to select one origin of SWUs instead of the other.

Table 2

SECONDARY MARKET INDIFFERENCE PRICES

Secondary Market Price for DOE SWUs (US$/SWU)	Buyer's Average Cost per SWU (US$/SWU)	Equivalent Secondary Market Price for Non-DOE SWUs (US$/SWU)
100	123.19	85.73
102 (Table 1)	123.99	86.53
105	125.19	87.73
110	127.19	89.73
115	129.19	91.73
120	131.19	93.73

The calculation of indifferent prices listed in Table 2 uses the following derivation, where **SMP** is the **secondary market price for DOE SWUs** and **EP** is the **equivalent price for non-DOE SWUs.**

1. EP = 60%(ISC price) + 40%(SMP) - Termination Charge.
2. EP = 60%($138.65) + 40%(SMP) - 25%($149.85).
3. EP = $83.19 + 40%(SMP) - $37.46.
4. **EP = $45.73 + 40%(SMP).**

The price that a seller of non-DOE SWUs would actually have to offer would then be determined by subtracting from the equivalent price the amount necessary to motivate buyers to prefer non-DOE SWUs. The incentive amount depends on each buyer's particular attitudes toward non-DOE SWUs; in the past the incentive has been as much as $10.

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Prior to DOE's July 25, 1983 offer of the original ISC, a price of $112.39 in the secondary market enabled holders of 3.5-year Requirements contracts to break even after termination charges. At that time, in order to draw buyers, sellers of DOE SWUs needed to offer at approximately $108 (a $4 termination incentive), while sellers of non-DOE SWUs needed to offer at approximately $100, (an $8 incentive *below the DOE price*). Upon the announcement of the original ISC, the break-even price after termination for 3.5-year Requirements contract holders dropped by $11.20, to the level of $101.19. Consequently, sellers of DOE SWUs reduced their offering prices to the range of $95-100 and sellers of non-DOE SWUs reduced their offering prices to approximately $90.

The modified ISC places a higher premium on DOE SWUs because of the free termination clause. Secondary market prices for DOE SWUs are already rising to the neighborhood of $115. Sellers recognize that even at prices approaching $115, buyers that accept the modified ISC still can achieve considerable savings. Prices could move even higher but for anticipated competition among sellers. There is a large supply of short-term DOE SWUs in the secondary market. With DOE SWUs at the $115 price level, the equivalent price for non-DOE SWUs is $91.73.

Holders of 5-year Requirements contracts are not being offered the modified ISC (just as they were not offered the original ISC), so their indifference price is a simple function of the Requirements contract price and termination charges. Allowing for a 40 percent termination charge on 5-year Requirements contracts yields an indifference price of 60%($149.85) = $89.91, a figure less than $2 below the equivalent price for non-DOE SWUs when prices of DOE SWUs are $115. Thus, the secondary SWU market is approaching the point at which holders of 5-year Requirements contracts can be drawn into the market in large numbers.

A 3.5-year Requirements contract holder that decides to accept the modified ISC naturally will want to contract for DOE SWUs in the secondary market to reduce average costs below the AFC price of $138.65 that is included in the ISC. Restricted to purchases of DOE SWUs in the secondary market, the buyer is vulnerable to increases in the price for DOE SWUs. If the secondary market supply of DOE SWUs were to prove insufficient to meet demand, the price could approach (or slightly exceed) the $130 level. Any greater price would remove any incentive to act. A price of approximately $130 should be regarded as the short-term ceiling on the price of DOE SWUs in the secondary market.

Therefore, utilities that plan to accept the revised ISC will wish to arrange their secondary market purchases for both FY84 and FY85 as soon as possible, perhaps even before accepting the modified ISC. In Nuexco's opinion, secondary market sellers of non-DOE SWUs will also actively pursue the potential market for FY85. The price and availability of FY85 SWUs of non-DOE origin will be a factor in some potential buyers' decisions to accept or decline DOE's offer.

In that case, assuming that DOE prices for FY85 are unchanged from FY83-84 and assuming a price of $115 for FY85 SWUs of DOE origin, the equivalent price for non-DOE SWUs would become $94.49, using the following derivation.

1. EP = 40%(ISC price) + 60%(SMP) - the 20% Termination Charge for FY85.
2. EP = 40%($138.65) + 60%($115) - $29.97.
3. EP = 55.46 + 69.00 - $29.97 = $94.49.

It is very difficult to determine if the modified ISC will improve DOE's net income or if DOE would be better off allowing its 3.5-year customers to terminate and pay the substantial termination fees. A definitive analysis of the costs and benefits to DOE would require consideration of several variables, including:

1. the percent of buyers that accept the contract and the associated number of SWUs terminated and produced thereof;
2. the number of SWUs DOE is contracted with primary market buyers to deliver in the relevant FY;
3. the number of SWUs that DOE is scheduled with its power sources to produce;
4. the charge per SWU for power-not-taken;
5. the fixed and variable costs (including imputed interest) of SWU production;
6. the number of SWUs that DOE has in inventory;

and a range of other variables not immediately obvious. Nuexco's limited analysis suggests that DOE is unlikely to gain a substantial amount of revenue in the short term by offering the modified ISC, and could even lose money. In the absence of an obvious financial gain to DOE for offering the new contract, the only prominent motive for the offer seems to be the possibility of regaining a monopoly on the US enrichment market.

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CURRENT MARKET DATA

EXCHANGE VALUE $23.50/lb. U_3O_8
Determined as of October 31, 1983

Definition[1]

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

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[1] In December, 1981, Nuexco published a history of the Exchange Value which chronicled, month-by-month, changes in its definition, usage and derivation. Copies are available upon request.

TRANSACTION VALUE[2]
Determined as of October 31, 1983

$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
23.65	2.0	21	6

Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

Comments

Nuexco does not consider the following in determining the Transaction Value:

A. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.
B. The price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of Exchange Value or any other independent variable. Also excluded from consideration are all data where the delivery price is defined in such a way that it cannot currently be determined.

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[2] Transaction Values for 1976 through 1981 and their associated parameters (millions of pounds, number of transactions and number of months) are tabulated on pages 31 and 32 of Report 161. Corresponding data for 1982 are tabulated on page 5 of Report 173.

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CURRENT MARKET DATA

LOAN USE CHARGE RATE[1] 6%
Determined as of October 31, 1983

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed as a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

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[1] Monthly data for 1968 through 1981 appear on pages 23-34 of Report 162. Monthly data for 1982 appear on page 2 of Report 173.

CONVERSION VALUE[2] $0.60/lb. U as UF_6
Determined as of October 31, 1983

Definition

The Conversion Value is Nuexco's judgment of the price at which spot and/or near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the last day of the month.

Derivation

Nuexco bases the Conversion Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Conversion Value:

A. The price of conversion services delivered or to be delivered under old contracts.
B. The price of conversion services delivered in connection with contract renegotiations or other than arm's length transactions.
C. Transportation charges other than those customarily provided by primary suppliers of conversion services.

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[2] Monthly data for 1981 and 1982 are tabulated on page 6 of Report 173.

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SWU VALUES

$115/SWU FOR DOE ORIGIN AND FY84 DELIVERY
$85/SWU FOR NON-DOE ORIGIN AND DELIVERY WITHIN 15 MONTHS
Determined as of October 31, 1983

Definition

The SWU (Separative Work Unit) Value is Nuexco's judgment of the price, expressed in U.S. dollars per SWU, at which transactions for the sale of significant quantities of SWU of stated origin for delivery in the specified time period could be concluded as of the last day of the month.

Derivation

Nuexco bases the SWU Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.
E. SWU prices at varying tails assays and varying product assays are converted to the equivalent SWU price at the DOE Reference Transaction Tails Assay (presently 0.20 weight percent U_{235}) and a product assay of three percent U_{235} assuming feed costs calculated using the Nuexco Exchange Value and Nuexco Conversion Value determined as of the last day of the same month.

Comments

Nuexco does not consider the following in determining the SWU Value:

A. The price of SWU delivered under long-term contracts from primary suppliers, such as DOE, Urenco, or Eurodif.
B. The price of SWU delivered under other than arm's length transactions.

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CURRENT MARKET DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
Australia (dollar)	25.60	56.44	66.55
Belgium (comm. franc)	1,228	2,707	3,192
Canada (dollar)	28.96	63.84	75.29
Finland (markka)	132.92	293.04	345.56
France (franc)	187.85	414.14	488.37
FRG (mark)	61.63	135.87	160.23
Italy (lira)	37,480	82,629	97,440
Japan (yen)	5,469	12,057	14,218
Netherlands (guilder)	69.10	152.33	179.64
South Africa (rand)	26.87	59.24	69.86
Spain (peseta)	3,571	7,874	9,285
Sweden (krona)	183.36	404.25	476.71
Switzerland (franc)	50.03	110.30	130.07
UK (pound)	15.71	34.63	40.84
US (dollar)	23.50	51.81	61.09

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
Australia (dollar)	25.76	56.80	66.98
Belgium (comm. franc)	1,236	2,724	3,212
Canada (dollar)	29.14	64.25	75.77
Finland (markka)	133.77	294.91	347.76
France (franc)	189.05	416.78	491.48
FRG (mark)	62.02	136.74	161.25
Italy (lira)	37,719	83,157	98,062
Japan (yen)	5,504	12,134	14,309
Netherlands (guilder)	69.54	153.31	180.78
South Africa (rand)	27.04	59.62	70.31
Spain (peseta)	3,594	7,924	9,344
Sweden (krona)	184.54	406.83	479.75
Switzerland (franc)	50.35	111.01	130.90
UK (pound)	15.81	34.85	41.10
US (dollar)	23.65	52.14	61.48

[1] Calculated using currency exchange rates published in the Wall Street Journal on October 31, 1983.

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CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U as UF₆	per kg U as UF₆
Australia (dollar)	0.65	1.44
Belgium (comm. franc)	31.35	69.11
Canada (dollar)	0.74	1.63
Finland (markka)	3.39	7.48
France (franc)	4.80	10.57
FRG (mark)	1.57	3.47
Italy (lira)	956.94	2,110
Japan (yen)	139.63	307.84
Netherlands (guilder)	1.76	3.89
South Africa (rand)	0.69	1.51
Spain (peseta)	91.19	201.03
Sweden (krona)	4.68	10.32
Switzerland (franc)	1.28	2.82
UK (pound)	0.40	0.88
US (dollar)	0.60	1.32

SWU VALUES EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU FY84	Non-DOE SWU delivery within 15 months
Australia (dollar)	125.27	92.59
Belgium (comm. franc)	6,008	4,441
Canada (dollar)	141.71	104.74
Finland (markka)	650.45	480.77
France (franc)	919.26	679.46
FRG (mark)	301.60	222.92
Italy (lira)	83,413	35,566
Japan (yen)	26,763	19,781
Netherlands (guilder)	338.14	249.93
South Africa (rand)	131.50	97.20
Spain (peseta)	17,477	12,918
Sweden (krona)	897.32	663.23
Switzerland (franc)	244.84	180.97
UK (pound)	76.87	56.82
US (dollar)	115.00	85.00

[1] Calculated using currency exchange rates published in the Wall Street Journal on October 31, 1983.

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CURRENT MARKET DATA

RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
2506A	1984	101-300	91	European Entity	US Utility	Enriched UF_6. Assumes $90 per SWU and conversion at $1.00 per lb. U as UF_6.
2511	1983	less than 50	103	European Utility	US Producer	
2512	1984	less than 50	102	Fabricator	Broker	Enriched UF_6. Assumes $100 per SWU and conversion at $1.10 per lb. U as UF_6.

Secondary Market Conversion Services

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U equivalent)	Approximate Price as Percent of Current C.V.	Seller	Buyer	Remarks
2505	1984	101-300	183	US Utility	European Utility	

Secondary Market Enrichment Services

Nuexco Transaction Number	Delivery Period[2]	Approximate Quantity (thousands of SWUs)	Approximate Price[3] as Percent of Current SWU Value[4]	Tails Assay (Percent U_{235})	Seller Group	Buyer Group	SWU Origin	Remarks
2506B	1984	50-100	105	.2	European Entity	US Utility	Eurodif	
2521	1984	50-100	less than 78	.2	European Entity	US Utility	DOE	
2525	1984	50-100	89	.2	European Utility	US Utility	DOE	
2545	1986	101-300	indeterminate	to be determined	European Utility	US Utility	DOE	escalated base price

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[1] Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.
[2] Refers to quarter of calendar year, not fiscal year.
[3] Price is not normalized to 0.20% tails assay.
[4] Comparison to SWU Value for same origin as SWUs included in transaction.

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URANIUM SUPPLY
(As of 10/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale: ACTIVE			
1575	—	500 per year	1985-92
1818	—	500 per year	1984-90
2038	2,000	—	UF_6
2134	—	250 per year	1984-87
2189	280	80	enriched UF_6
2201	300	—	
2203	1,000	—	
2220	150	—	UF_6
2235	—	150 per year	1985-87
2236	—	200 per year	1985-89
2245	450	—	
2246	40	100	
2275	100	—	
2288	80	—	UF_6
2297	60	200 per year	1985-89
2307	200	—	UF_6
2315	150	950	UF_6
2320	350	—	UF_6
2365	20	—	
2366	600	—	
2376	100	—	U_3O_8 or UF_6
TOTAL:	5,880		
INACTIVE			
2017	—	2,300	
2271	—	500 per year	1984-85
2191	125	—	UF_6
2193	—	800 per year	1986-90
2309	950	—	
TOTAL:	1,075		

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[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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CURRENT MARKET DATA

URANIUM DEMAND
(As of 10/31/83)

	Delivery Period[1] (Thousands of Pounds U_3O_8)		
Nuexco Project Number	Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
1459	—	200 per year	1985 on
2167	250	250 per year	1984-89
2187	120	—	
2188	—	250 per year	1986 on
2233	700	—	U_3O_8 or UF_6
2238	270	—	enriched UF_6
2266	450	—	
2302	—	250 per year	1987 on
2304	—	500 per year	1987 on
2310	800	—	enriched UF_6
2313	260	255	
2329	—	500	1985
2357	130	—	enriched UF_6
2372	—	250 per year	1985-88
2393	45	—	enriched UF_6
2416	—	430	
2419	50	—	
TOTAL:	3,075		
INACTIVE			
1999	—	50 per year	1985-90
2010	—	400 per year	1984-92
2025	—	350	
2114	—	75 per year	1984 on
2118A	250	—	
2371	—	260	1984-90 UF_6
2244	—	350 per year	1985 on
TOTAL:	250		

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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LOAN SUPPLY AND DEMAND
(As of 10/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Within 1 Year	Beyond 1 Year	Remarks
Available for Loan: **ACTIVE**			
1815	1,000	—	UF_6
1938	1,500	—	UF_6
2128	1,000	—	
TOTAL:	3,500		
INACTIVE			
1884	600	—	
2036	500	—	UF_6
2139	2,000	—	
TOTAL:	3,100	—	
Inquiries to Borrow: **ACTIVE**			
2118	250	—	U_3O_8 or UF_6
TOTAL:	250		

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[1] Measured from the date of this Report

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CURRENT MARKET DATA

CONVERSION SUPPLY
(As of 10/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF6) Within 3 Years	Beyond 3 Years	Remarks
ACTIVE			
1936	1,500	—	
2051	1,500	—	
2141	1,500	—	
2143	300	—	
2220	400	—	
2222	80	175	
TOTAL:	5,280		
INACTIVE			
1609	1,500	—	
2181	2,000	650 per year	1985-90
2230	300	—	
2401	600	—	
TOTAL:	4,400		

CONVERSION DEMAND
(As of 10/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF6) Within 3 Years	Beyond 3 Years	Remarks
ACTIVE			
2129	900	—	
2380	700	—	
2386	190	—	
2420	300	—	
TOTAL:	2,090		
INACTIVE			
2190	400	200 per year	1986 on
2194	—	300 per year	1986 on
2287	250	250	
2295	200	—	
TOTAL:	850		

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[1] Measured from the date of this Report.

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SWU SUPPLY
(As of 10/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
1859	—	1,000	
2100	—	200	
2164	120	—	
2210	—	150	1985
2273	—	200	1985
2285	500	3,000	
2345	—	500	1985
2351	—	150 per year	1986-91
2375	200	—	
2378	—	120 per year	1985-89
2385	300	—	
2408	—	120	1985
TOTAL:	1,120		
INACTIVE			
2052	200	—	
2040	50	—	
2137	80	80 per year	1984 on
2192	—	410	
2218	250	250	
TOTAL:	480		

[1] Measured from the date of this Report.
[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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CURRENT MARKET DATA

SWU DEMAND
(As of 10/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2233	250	—	
2272	—	200	
2280	—	100	1985
2282	—	300	
2310	200	760	
2355	—	180 per year	1986,88,90,92
2356	5	—	
2362	150	—	
2377	—	80	1987
2400	—	85	1985
2412	—	80	1985
TOTAL:	605		
INACTIVE			
2142	—	35	1985
2237	—	150 per year	1985 on
2339	—	50	1989
2418	—	100	1987

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[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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AUSTRALIA

The Cabinet of Australia's Labor government recently made four recommendations to the Labor Party (ALP) caucus which are expected to receive the caucus' approval.

1. The Roxby Downs project in South Australia should be allowed to proceed.
2. Ranger and Nabarlek, the country's only operating projects, should continue to produce and Ranger's two additional proposed contracts with US utilities should be approved.
3. No new export contracts should be allowed and no uranium projects other than Roxby Downs should be activated until a public inquiry into nuclear safeguards, waste disposal and non-proliferation is concluded.
4. A permanent commission should be established to advise the government on uranium policy, to investigate issues relating to the nuclear fuel cycle, and to monitor Australia's position in the nuclear fuel market.

* * *

Recently, the Minister for Environment recommended to the Cabinet that the federal government expand the Kakadu National Park in the Northern Territory to include 6,000 square kilometers, in accordance with promises the ALP made upon gaining office last year. Such an action would lead to the revocation of hundreds of exploration licenses and the planned Jabiluka project, which falls within the proposed boundaries of the park, could not proceed. Previously the minister had recommended that the controversial region be declared a conservation area rather than a national park in order to allow for mining and exploration. Environmentalists have lobbied hard to eliminate mining from the region altogether. However, the new proposal is likely to be opposed by several members of the Cabinet, including the Minister for Resources and Energy and the Minister for Trade.

* * *

Queensland Mines Ltd. is converting the leaching process at its Nabarlek uranium mill in the Northern Territory from pyrolusite to Caro's acid. Extensive plant trials at Nabarlek confirmed that significant savings in acid and lime usage can be achieved by using Caro's acid (permonosulfuric acid), without affecting uranium extraction.

JAPAN

In October the Ministry of International Trade and Industry (MITI) released its most current figures for construction and generation costs for the five main electric power plant types. The figures are summarized in Table 3.

Table 3

COMPARISON OF CONSTRUCTION AND POWER GENERATION COSTS FOR ALTERNATE ELECTRICITY SOURCES: JAPAN

Plant type	Construction Cost (thousands of yen per kilowatt of plant capacity)	Generation Cost (yen per kilowatt-hour of electricity)
Hydroelectric	610	20
Oil	130	17
Coal	230	14
LNG	180	17
Nuclear	300	12.5

The generation cost for nuclear power increased 0.5 yen per kilowatt-hour compared to 1982, while fossil fuel costs declined 1-3 yen per kilowatt-hour, primarily because of conditions in the oil market. Nuclear power still has a clear long-term advantage over alternative electricity sources. For nuclear power to maintain its advantage, MITI emphasized the importance of reducing capital costs.

* * *

On October 18, thirteen years after a construction permit was issued, Tohuku Electric Power Company's Onagawa Unit 1 achieved criticality. Construction time for the 524 MWe BWR was approximately twice as long as for most reactors in Japan, which has a record of efficiency in plant construction. Delays were attributed in part to drawn-out compensation negotiations with a fishermen's association. Onagawa 1 is slated for commercial operation in June 1984.

SOUTH AFRICA

Uranium production in South Africa from gold-uranium operations for the third quarter of 1983 and the year-to-date is itemized in Table 4.

The table includes all of South Africa's uranium producers except for Palabora Mining Company (PMC), which is not a member of the Chamber of Mines. Total third quarter production of approximately 3.9 million pounds U_3O_8 was almost identical to the previous quarter's output. On the up side, BEISA's St. Helena operation produced 34 thousand pounds more than in the second quarter and JMS produced 27 thousand pounds more. Declines in production were noted by Vaal Reefs, down 41 thousand pounds, and Harmony, down 28 thousand.

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RECENT DEVELOPMENTS

Table 4

REPUBLIC OF SOUTH AFRICA: URANIUM PRODUCTION FROM GOLD-URANIUM OPERATIONS

(Thousands of Pounds U_3O_8)

Operation	Third Quarter 1983	Year to Date
Blyvooruitzicht	180	514
Buffelsfontein	337	983
Chemwes	320	885
Dreifontein Consolidated	85	281
ERGO	124	351
Harmony	335	1,064
Hartebeesfontein	252	727
JMS	411	1,166
Randfontein	270	802
St. Helena (BEISA)	267	698
Vaal Reefs	1,042	3,143
Western Areas	170	460
Western Deep Levels	107	295
TOTAL	3,900	11,369

UNITED STATES

During October Nuexco resurveyed US uranium producers with facilities operating in 1983 to ascertain expected production for the year. The results indicate that US U_3O_8 production in 1983 will be approximately 19.7 million pounds. Nuexco's Free World production forecast shown last month in Report 182 (October 1983) had estimated 1983 US production at 16.3 million pounds.

The new amount is higher than previously anticipated for several reasons.

1. Some producers continued to mill ore stockpiled at mines shut down in 1982.
2. Milling capacity increased as some conventional mills previously shut down were reopened.
3. Some mills increased mill throughput and processed higher-grade ore during 1983 than in 1982.
4. One phosphate by-product producer swapped phosphate rock for rock with higher uranium content.
5. The phosphoric acid business is doing better than predicted so uranium by-product production has increased.

Despite the upward revision of the 1983 production estimate, Nuexco expects that 1984 will be a milestone year for several US uranium producers. Inventory buildup can be an indication that a production facility will be closing and that stockpiled yellowcake will be used to supply customers. Known and expected supply commitments would require some mills to operate at less than 50 percent of capacity in 1984. Those mills are likely to be shut down rather than run at a significant loss. US producers indicate that it is too early to estimate 1984 output, but Nuexco's present forecast is approximately 15 million pounds.

CORRECTIONS

Report 182 for October 1983 contained four particularly noticeable errors.

1. The second sentence of the *Executive Summary* reads, "Two uranium sales transactions are reported, involving approximately 260 million pounds U_3O_8 *equivalent*." The amount indicated should be 260 thousand pounds.
2. On page 16 in the Recent Developments section, the third sentence of the Japan article should read, "On July 26, 1983 a new record of 94,772 MWe was established, which in turn was broken by a total of 99,337 MWe on August 5."
3. On page 20, in the article entitled *Summary of DOE SWU Contracts*, there is an error in Table 6, which details termination charges for Requirements contracts. The table indicates that 3.5-year contract holders that terminate 2-3 years before delivery must pay a 20 percent termination charge, and that 3.5-year holders that terminate 3-3.5 years before must pay a 15 percent charge. In actuality, termination 2-3 years before delivery results in a charge of 15 percent, while termination 3-3.5 years ahead of schedule results in a charge of 10 percent.
4. In the photograph on page 35 representing Figure 6 of the Raw Materials article, the number 2, which should represent the crushing circuit, is barely visible near the right bottom corner of the figure. The crushing circuit is the tall complex at the far right of the photograph. The pressure leach circuit is the system located directly above the number 3 in the figure.

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ESSAY

SHIFTING PATTERNS OF URANIUM SUPPLY AND DEMAND

The nuclear fuel market over the last fifteen years has exhibited three distinct patterns.

1. Producers sell to users in the *primary market*.
2. Some producers buy back from users in the *secondary market for natural uranium*.
3. Users sell to users through *secondary markets for conversion and enrichment services*.

The most interesting aspect of these three patterns, and the most important to understand, is the shifts of emphasis over time from one pattern to the next. While primary market sales of uranium concentrates dominated the early years of the nuclear fuel market, the focus has shifted to the secondary markets. The shifts from one pattern to the next have had strong effects on spot and near-term price movements.

Pattern #1: Primary Market Sales

From the inception of the uranium industry through the late 1970s, users purchased essentially all of their nuclear fuel needs from producers in the primary markets. Little activity took place in secondary markets. Users generally held in inventory any excess purchased material; conversion and enrichment contracts seldom were transferred from one user account to another. During that period, marketing and procurement activities required little sophistication or creativity. The main objective of buyers was to determine future requirements and procure fuel at fixed prices or through relatively low-risk pricing formulas. The main objective of sellers was to conclude long-term sales for large portions of their production capacity.

The rise of oil prices in the early 1970s caused security of fuel supplies to become a primary concern of utility management. Long-term purchasing activity increased and prices rose sharply. At the time it seemed prudent to secure fuel supplies at virtually any price. By April 1976, spot prices for uranium concentrates had reached the $40 per pound level.

Primarily motivated by high nuclear electricity demand forecasts and uncertainty about the extent of uranium reserves, users signed contracts for large quantities of uranium and conversion and enrichment services. Resource limitations and demand forecasts both turned out to be overstated. Between 1976 and 1980, reactor cancellations and delays contributed to the massive build-up of user inventories, while discoveries of extensive high-grade uranium deposits dispelled uncertainties about resources.

Pattern #2: Secondary Market Sales of Uranium Concentrates

The pattern of simple producer-to-user transactions began to give way in 1980 to the opposite pattern. Holders of large uranium surpluses, both producers and users, sold to producers at low prices, setting in motion a rapid price decline. Utilities faced such extreme surpluses that they could sell to producers even after filling inflexible conversion and enrichment contracts. Pressure to liquidate inventories came from cash considerations, high interest rates, intervenors, auditors and regulators.

Buying back yellowcake at falling prices enabled producers with contracts having base prices on the order of $40 per pound to cover operating costs and continue to fulfill their contract obligations at a profit. For producers with excessively high operating costs, who could only survive in a high priced market, it became economical to shut down operations and fill contracts with uranium bought in the secondary market. High-cost producers holding contracts referenced to market prices suffered losses, and production rates fell rapidly in low-grade areas after 1980.

In July 1982 approximately 90 percent of the active spot and near-term supply of uranium was being offered by users, while 70 percent of the active demand was from producers. The shift in the market resulted from creative and innovative thinking on the part of market participants. For utility management, price replaced security of supply as the most important consideration. Utilities that had previously signed contracts having base-escalated pricing mechanisms sought market-related prices in their new contracts. Public utility commissions put pressure on utilities not to pay more than spot prices at the time of delivery. Utilities exhibited a willingness to purchase material produced outside the USA, and the market took on a more international quality. While uranium remained the main focus of attention, means of liquidating conversion and enrichment commitments began to attract significant interest. As much as six years' forward consumption still remained in user inventories, much of it in the form of natural and enriched UF_6.

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Pattern #3: Secondary Market Sales of Conversion and Enrichment

Utilities holding contracts for excessive conversion and enrichment services or owning large blocks of natural or enriched UF_6 had come to realize that they could reduce their borrowing at prevailing high interest rates by selling commitments and inventories in the secondary markets. Users began to sell to other users who, by making adjustments to their contracts with primary sellers of fuel cycle services, found ways to make such transactions economically beneficial.

Conversion services can be purchased in the secondary market at less than half their cost in the primary market. Enrichment services can be purchased in the secondary market for substantially less than the prices charged by Eurodif and DOE, the dominant primary market suppliers.

The primary market suppliers of enrichment services cannot compete with secondary market prices without accepting substantial revenue losses, because of the high real costs of enrichment services. The main primary enricher, DOE, also is obligated by law to price its services to achieve full cost recovery. Recently DOE has lowered the cost of primary market enrichment services for holders of Requirements contracts having 3.5-year fee termination provisions in order to stifle the secondary market, and especially to eliminate the sale of Eurodif SWUs in the US. DOE is also considering the granting of price concessions to holders of Requirements contracts having 5-year fee termination provisions.

Conclusion

Today the nuclear fuel market is characterized by a mixture of all three patterns. Producers are selling to users. Some producers are purchasing uranium from inventory holders, although the level of activity of that pattern is much reduced from its highpoint in 1982. The main emphasis today is on the secondary enrichment market, and to a lesser degree the secondary conversion market. Unfettered, secondary markets provide relief to users holding costly excesses and restore equilibrium to free market systems. In the nuclear fuel market, as user inventories come back into balance, emphasis could shift once again to primary markets (pattern #1). However, if secondary market activities (pattern #3) are stifled, the return to a nuclear fuel market emphasizing primary sales could be delayed for years.

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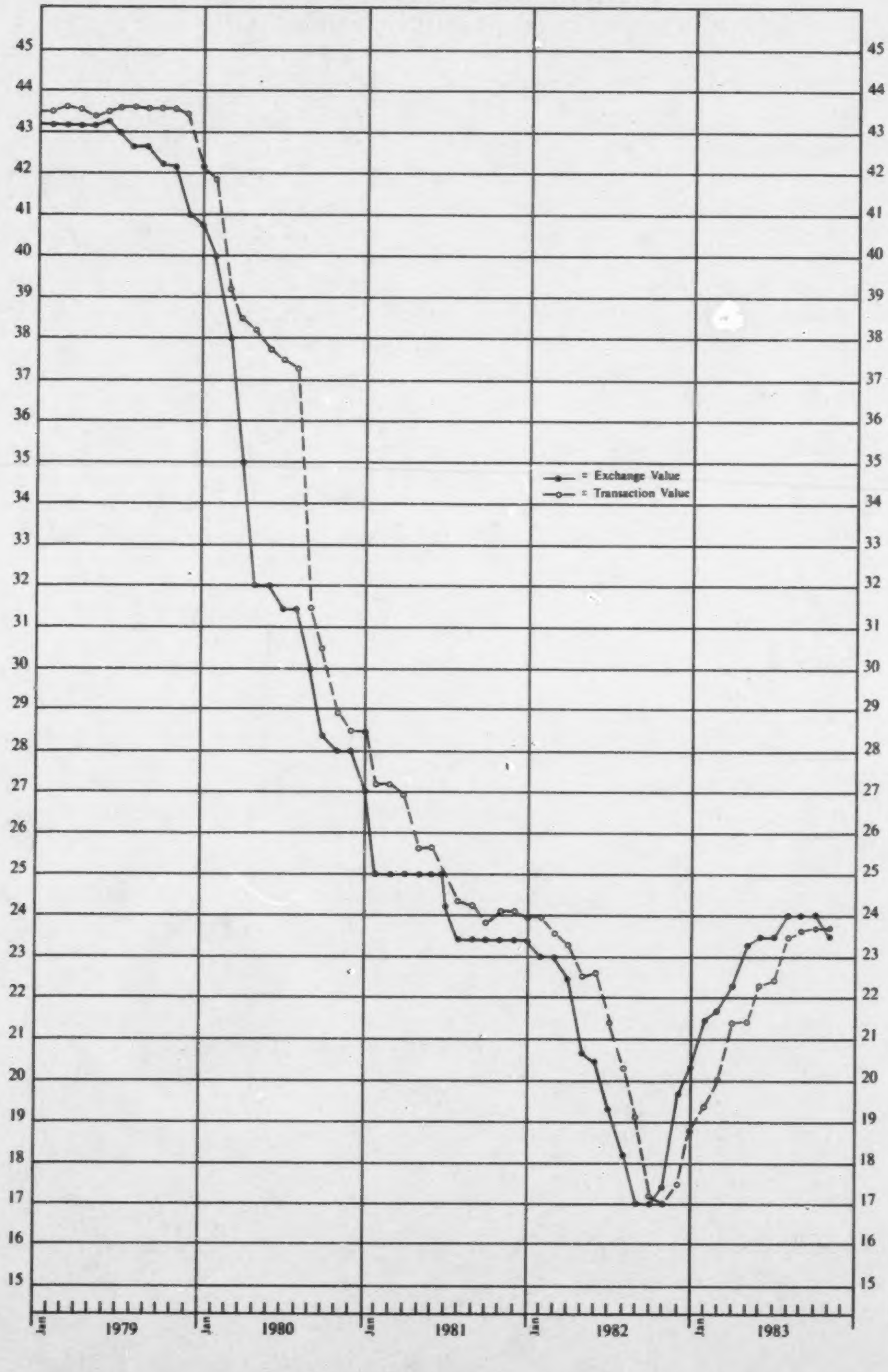
EXCHANGE AND TRANSACTION VALUES SINCE JANUARY 1979

Determined as of the last day of the month indicated



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HISTORICAL MARKET DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	**23.50**		

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	**23.65**		

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	**0.60**		

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AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups (Year 1968-69 = 100.0)[1]	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage Earners, Weekly Rates (Year 1976 = 100.0)[2]
Annual Avg. 1972[3]	105.6	71.26
Annual Avg. 1973[3]	124.4	78.96
Annual Avg. 1974[3]	141.9	108.07
Annual Avg. 1975[3]	150.4	132.55
Annual Avg. 1976[3]	168.4	160.93
Annual Avg. 1977[3]	192.0	179.03
Annual Avg. 1978[3]	198.5	190.04
Annual Avg. 1979	248.8	196.34
Annual Avg. 1980	321.8	218.00
Annual Avg. 1981	355.3	237.34
Annual Avg. 1982	368.5	174.88
Jun 1982	367.8	173.2
Jul 1982	370.0	177.2
Aug 1982	372.5	178.2
Sep 1982	375.2	178.4
Oct 1982	378.4	178.4
Nov 1982	375.8	178.5
Dec 1982	374.8R	179.5
Jan 1983	385.6R	179.6
Feb 1983	387.4R	179.5
Mar 1983	397.3R	179.4
Apr 1983	407.4R	179.7
May 1983	414.9P	179.8
Jun 1983	415.8P	179.9
Jul 1983	—	179.5
Aug 1983	—	179.5P

P = Preliminary R = Revised since last month

[1] Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

[2] Australian Bureau of Statistics, Canberra: "Award Rates of Pay Indexes, Australia" (Catalogue No. 6312.0), Table 8. Figures for the latest fourteen months shown are subject to revision.

[3] Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Nuexco Report 138.

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GOVERNMENT STATISTICS

CANADA

	Industry Selling Price Index: Manufacturing (D 500000)[1] [2] (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings (C$)[4] [5] [6]				
		Metal Mining, including Milling (SIC 050-099)[3]	(SIC 296)	Primary Metal Industries, non-ferrous (SIC 296-298)[7]	(SIC 298)	Chemicals and Chemical Products (SIC 372-379)[8]
Annual Avg. 1979	217.9	9.66	—	7.35	—	7.67
Annual Avg. 1980	247.2	10.80	—	8.05	—	8.50
Annual Avg. 1981	288.7	12.23	—	9.03	—	9.53
Annual Avg. 1982	288.8	13.92	—	9.98	—	10.63
Jul 1982	290.3	14.02	—	10.05	—	10.73
Aug 1982	290.3	14.23	—	10.03	—	10.80
Sep 1982	292.4	14.01	—	10.18	—	10.73
Oct 1982	292.1	13.89	—	10.18	—	10.86
Nov 1982	291.3	14.28	—	10.43	—	10.90
Dec 1982	292.3	14.32	—	10.55	—	11.06
Jan 1983	292.7	14.35	—	10.72	—	11.06
Feb 1983	293.5	14.28	—	10.74	—	11.06
Mar 1983	295.2	14.48	—	10.93	—	11.21
Apr 1983	297.1	14.13	11.57	—	10.10	11.02
May 1983	298.5	14.10	11.39	—	9.82	10.97
Jun 1983	299.2	14.07	11.33	—	9.84	11.05
Jul 1983	300.3R	13.93R	11.70R	—	9.83R	11.04
Aug 1983	301.0R	13.71P	11.84P	—	10.08P	11.17P
Sep 1983	300.6P	—	—	—	—	—

P = Preliminary R = Revised since last month

[1] Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

[2] Monthly data for 1973 through 1978 appear on page 4.10 of Nuexco Report 138.

[3] The wage earner series in Nuexco reports prior to March 1983 was Metals (SIC 050-059).

[4] Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

[5] Monthly data for 1977 and 1978 appear on page 4.11 of Nuexco Report 138.

[6] Beginning with the April 1983 figure, Wage Earner Data are based on a census of all companies employing 200 or more wage earners, *plus* a random survey of companies employing fewer than 200 wage earners. Prior to April 1983 only companies employing 200 or more wage earners are included in the Wage Earner Data.

[7] Beginning with the April 1983 figure, Primary Metal Industries, non-ferrous is split into SIC 296 and SIC 298.

[8] Chemical and Chemical Products prior to April 1983 was SIC 370-379. The new series is from a new survey which includes all companies and is based on a 1970 classification. The old survey included companies of 20 employees or more.

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REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100, except where otherwise indicated)	Producer[5] Price Index All Groups (1975 = 100)	Total Employment in Mining and Quarrying (Code 35)[7]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[7]
Annual Avg. 1972[3]	8.79	113.3[4]	63.9	623,067	443,933
Annual Avg. 1973[3]	10.51	124.1[4]	72.3	684,743	572,133
Annual Avg. 1974[3]	13.18	138.5[4]	85.3	674,140	761,596
Annual Avg. 1975[3]	16.71	157.2[4]	100.0	639,473	1,003,617
Annual Avg. 1976[3]	19.30	174.7[4]	115.1	671,240	1,212,983
Annual Avg. 1977[3,6]	23.87	194.4[4]	130.0	712,006	1,420,670
Annual Avg. 1978[3,6]	27.14	137.2	142.7	664,571	1,537,169
Annual Avg. 1979[3,6]	30.18	155.3	164.5	692,209	1,830,632
Annual Avg. 1980[6]	35.53	176.7	192.1	714,379	2,279,615
Annual Avg. 1981	41.89	206.5	218.3	728,506	2,820,505
Annual Avg. 1982	47.25	233.5	248.7	707,552	3,246,071
Apr 1982	—	228.9	241.9	707,502	252,562
May 1982	—	230.3	244.8	715,162	258,770
Jun 1982	45.77	232.1	246.7	707,552	261,361
Jul 1982	—	234.1	249.4	702,141	283,248
Aug 1982	—	236.8	253.4	705,562	276,730
Sep 1982	48.04	241.0	255.0	704,344	282,782
Oct 1982	—	243.9	260.1	701,316	285,328
Nov 1982	—	245.4	262.5	707,966	287,699
Dec 1982	49.62	246.2	263.0	683,982	288,019
Jan 1983	—	249.0	264.9	688,030	289,075
Feb 1983	—	253.1	267.4	697,089	281,413
Mar 1983	50.35	255.9	269.1	695,976	290,586
Apr 1983	—	257.8	270.9	697,158	286,708
May 1983	—	259.7	274.1	701,712	295,701
Jun 1983	50.51	260.8	273.1	706,933	300,177
Jul 1983	—	262.5	273.7	704,202	314,566
Aug 1983	—	265.6	278.9	—	—
Sep 1983	—	267.3	—	—	—

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[1] Chamber of Mines of South Africa, Johannesburg: "Analysis of Working Results," published quarterly. The tonnage-weight index of average working costs per metric ton of gold ore milled for 1983 is as follows. (Base: March quarter 1982 = 100). See Nuexco report #178 page 24 for the tonnage-weighted index for 1982. Description and calculation of the index is on page 16 of Nuexco report #178.

1983:		
1983:	January-March	111.2
	April-June	111.9

[2] Republic of South Africa Department of Statistics, Pretoria: "Government Gazette: Consumer Price Index for Urban Areas."

[3] Historical data for the Average Declared Working Costs and Consumer Price Index 1970-1979 appear on page 4.9 of Nuexco Report 140.

[4] April 1970 = 100.00.

[5] Previously known as the WHOLESALE PRICE INDEX, now the PRODUCER PRICE INDEX. The computation remains the same.

[6] Historical data for Codes 35 and 40 1977-1980 appear on page 28 of Nuexco Report 157.

[7] Bulletin of Statistics, Department of Statistics, Pretoria.

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GOVERNMENT STATISTICS

UNITED STATES

	Producer Price Index— Industrial Commodities (1967 = 100)[1]	Producer Price Index— All Commodities (1967 = 100)[1]	Consumer Price Index (1967 = 100)[2]	GNP Implicit Price Deflator (1972 = 100)[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
					Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
Annual Avg. 1972[5]	117.9	119.1	125.3	100.00	4.56	4.59	4.26	3.71
Annual Avg. 1973[5]	125.9	134.7	133.1	105.75	4.84	4.98	4.51	3.91
Annual Avg. 1974[5]	153.8	160.1	147.7	115.08	5.44	5.63	4.88	4.21
Annual Avg. 1975[5]	171.5	174.9	161.2	125.79	6.13	6.24	5.39	4.64
Annual Avg. 1976[5]	182.4	183.0	170.5	132.34	6.76	6.87	5.91	4.96
Annual Avg. 1977[5]	195.1	194.2	181.5	140.05	7.28	7.67	6.43	5.39
Annual Avg. 1978[5]	209.4	209.3	195.4	150.42	8.23	8.56	7.02	5.82
Annual Avg. 1979[5]	236.5	235.6	217.4	163.42	9.27	9.50	7.60	6.32
Annual Avg. 1980[5]	274.8	268.8	246.8	178.64	10.26	10.63	8.30	6.94
Annual Avg. 1981	304.1	293.4	272.4	195.51	11.55	11.98	9.12	7.62
Annual Avg. 1982	312.3	299.3	289.1	207.15	12.33	12.94	9.96	8.21
Sep 1982	312.7	299.3	293.3	208.51	12.53	13.51	10.19	8.37
Oct 1982	314.3	299.8	294.1	—	12.51	13.26	10.22	8.41
Nov 1982	315.0	300.3	293.6	—	12.53	13.22	10.26	8.45
Dec 1982	315.2	300.7	292.4	210.00	12.53	13.05	10.32	8.51
Jan 1983	313.9	299.9	293.1	—	12.63	13.33	10.34	8.53
Feb 1983	313.9	300.9	293.2	—	12.66	13.29	10.41	8.56
Mar 1983	313.5	300.6	293.4	212.83	12.48	13.35	10.39	8.60
Apr 1983	312.4	300.6	295.5	—	12.67	13.34	10.43	8.60
May 1983	313.6R	301.5R	297.1	—	12.55	13.62	10.50	8.60
Jun 1983	315.4	302.5	298.1	214.55	12.66	13.38	10.52	8.63
Jul 1983	316.6	303.2	299.3	—	12.68R	13.56R	10.58R	8.69R
Aug 1983	317.5	304.9	300.3	—	12.63P	13.48P	10.60R	8.64R
Sep 1983	317.2P	305.3P	301.8P	216.37P	—	—	10.73P	8.77P

P = Preliminary R = Revised since last month

[1] US Bureau of Labor Statistics, Washington, D.C.: "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

[2] US Bureau of Labor Statistics, Washington, D.C.: Consumer Price Index for All Urban Consumers, US City Average, All Items.

[3] US Department of Commerce, Washington, D.C.: Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table 7.1. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

[4] US Bureau of Labor Statistics, Washington, D.C.: "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for 1977-1978 are adjusted to the March 1979 benchmark. Data for January 1979 and beyond are adjusted to the March 1980 benchmark.

[5] Monthly data 1970-1978 for Producer Price Index-Industrial Commodities, Consumer Price Index, and Employment and Earnings SIC codes 10, 333, and 28, and quarterly data for GNP Implicit Price Deflator appear on pages 4.6-4.8 of Nuexco Report 139.
Monthly data 1977-1978 for Employment and Earnings SIC Codes 10, 333, and 28 appear on page 33 of Nuexco Report 147.
Monthly data 1970-1978 for Employment and Earnings SIC Code 36 appear on page 23 of Nuexco Report 154.
Monthly data 1979-1980 for Employment and Earnings, Revised Establishment Data, all listed codes, appear on page 22 of Nuexco Report 158.
Monthly data 1977-1980 for Producer Price Index-All Commodities, appear on page 21 of Nuexco Report 158.

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SPECIAL REPORT NOVEMBER 1983

The Secondary Market for Enrichment Services

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To Our Readers

On October 21, 1983, Mr. J. R. Wolcott, Nuexco's chairman and chief executive officer testified before the Conservation and Power Subcommittee of the US House of Representatives Energy and Commerce Committee. The hearing dealt with the US Department of Energy (DOE) enrichment program, its goals and its strategy to achieve those goals. As the only witness invited from the commercial sector, Mr. Wolcott spoke on the secondary enrichment market. Part One of this Special Report presents Mr. Wolcott's testimony, slightly edited for this publication. Mr. Wolcott's prepared remarks are followed by his responses to questions posed by the subcommittee's chairman and its legal counsel.

Part Two of this Special Report presents excerpts from other testimony presented at the hearing. Although the other witnesses focused on the primary market and on DOE's overall program, those things are so influential over the secondary market that they are worthy of attention from anyone interested in the nuclear fuel market.

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PART ONE: WOLCOTT TESTIMONY

THE SECONDARY MARKET FOR ENRICHMENT SERVICES

by

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Energy and Commerce Committee
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Summary

1. Secondary markets have developed in the uranium fuel cycle out of users' needs to restore supply and demand balance. A secondary market consisting of user-to-user sales has become a permanent feature of the enrichment services (SWU) market.

2. Penetration into the US market by non-US enrichers is modest, presently a little over 10 percent of US users' needs, and probably would continue to be modest for several years if DOE took no retaliatory action. I know of no *long-term* contracts for non-US enrichment services having been placed to date in the USA, although the possibility exists.

3. Although DOE is competing with secondary market sellers, it operates under government and commercial constraints that make it difficult to compete in a constructive or effective way.

4. Even if DOE had the flexibility required to follow secondary market prices effectively, to do so would erode the primary market structure in which DOE will compete for the long term. The result would be substantial revenue losses.

5. Frustrating the secondary market interferes with the very mechanism that will correct users' imbalances and restore the long-term health of the primary SWU market. Pushing imbalances into the future will simply create more severe problems than now exist and delay the resolution of unhealthy market conditions that eventually must be corrected in any event.

Introduction

My name is J. Robert Wolcott. I am the Chairman and Chief Executive Officer of Nuexco, a professional services company specializing in the nuclear fuel market. Our business activities fall into three categories: brokerage, consulting and information dissemination.

1. Our primary vehicle for information dissemination, the Nuexco Monthly Report on the Nuclear Fuel Market, has approximately 400 domestic and international subscribers.

2. As consultants, we develop analyses of supply and demand, prices, strategies for procurement and marketing of nuclear fuel materials and services.

3. Finally, we are brokers of fuel cycle materials and services. We are not traders. We do not take principal positions for our own risk and account. Similarly, our standard fees are related to quantities of material transacted and not to the price of the transaction. From a business standpoint, we are indifferent to secondary market prices.

Nuexco has a large international involvement. More than half of our brokerage transactions involve at least one non-US party.

Headquarters are located in Menlo Park, California. Regional offices are located in Stamford, Connecticut, Atlanta, Georgia, and in France near Geneva, Switzerland. In addition, we have a network of twelve representatives and special consultants located in the most important regions of nuclear fuel users and suppliers.

My topic is the secondary market for enrichment services—what it is; why it exists; its impact upon primary market suppliers, especially DOE; and the impact DOE actions might have on the secondary market.

The Present Situation

At one time the USA was virtually the only commercial supplier of enrichment services, both to US and non-US customers. Primary market competition developed as Eurodif, Urenco, and Techsnabexport (USSR) began selling to DOE's non-US customers. Today DOE supplies about 35% of non-US needs.

When US utilities signed their present enrichment contracts, they had virtually no alternative to DOE (Exhibit 1 summarizes the terms and conditions of six types of USDOE enrichment contracts). DOE at first supplied virtually 100 percent of US customers' enrichment needs. Until recently, the secondary market consisted mainly of assignments of Adjustable Fixed Commitment (AFC) contracts from one DOE customer to another. Recently the secondary market has developed in such a way that European sellers now are supplying enrichment services and enriched product to US users. Some of the SWUs supplied by those European sellers to US buyers have been obtained under AFC contracts. A larger part is of Eurodif origin. However, DOE still supplies almost 90

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percent of US users' current needs. (Exhibit 2 discusses the development of the secondary SWU market in detail.)

US users are consuming non-DOE enrichment services purchased on the secondary market at an annual rate of approximately 12 percent of needs. Approximately the same rate will probably prevail in 1984 and 1985. No long-term commitments for the supply of Eurodif SWUs are known to have been made in the United States to date.

Several fundamental changes have taken place in the primary and secondary SWU markets over the past two years. Some of them constitute the proximate causes of DOE's aggressive efforts to maintain 100 percent of the US market. On the other hand, some of the changes have been brought about by DOE's actions against the secondary market participation by sellers of non-DOE SWUs.

1. For five years or more, DOE has been losing business in non-US markets, and particularly in Europe. Much of the loss has resulted from European clients' annoyance with the US non-proliferation policies instituted by President Carter. A related influence has been the desire on the part of DOE's European customers for self-sufficiency throughout the nuclear fuel cycle. For example, West German customers terminated a number of DOE contracts in favor of Techsnabexport (USSR) and Urenco. In other cases, European customers of DOE sold their DOE commitments to U.S. customers of DOE, usually replacing the buyers' corresponding DOE commitment.

2. Two years ago, before Eurodif enrichment services were being offered to the US market, DOE had no domestic competition. Once European SWUs began to penetrate the US market, DOE became concerned about the loss of its domestic market, and has reacted with efforts aimed at maintaining 100 percent of the US market. DOE has taken four notable actions with those objectives in mind.

a. By holding SWU prices at their current levels when the latest price determination was made earlier this year, DOE interrupted a string of SWU price increases dating back ten years.

b. The Interim Sales Contract (ISC), sometimes called the mini-deal, offers holders of requirements contracts having 3.5-year termination provisions the opportunity to pay the lower AFC price for SWUs, in exchange for which they would agree not to terminate SWU deliveries for FY83-85. (Exhibit 4 discusses in more detail the secondary market impact of the ISC.)

c. DOE is proposing the Utility Services enrichment contract (USEC), the exact terms and conditions of which have not yet been revealed. The forerunner to the USEC, known as the Facility Requirements (FR) contract, was issued in draft form more than a year ago. (Exhibit 5 discusses in more detail the secondary market impact of the draft FR contract.) Preliminary comments from DOE and from utility executives who have been invited to review the current version indicate that the USEC will give DOE clients more favorable terms and conditions in exchange for the surrender of their rights to use non-US enrichment services. (Exhibit 9 discusses Nuexco's analysis of the likely market response to the USEC.)

d. DOE has most recently offered to holders of 3.5-year Requirements contracts a modified ISC, which gives the customer freedom to substitute *at no charge* SWUs obtained on the secondary markets for up to 40 percent of requirements for FY84 and up to 60 percent of requirements for FY85, but *only* by using DOE SWUs. In exchange, the customer must agree in principle to accept the USEC when issued if it is at least as advantageous to the customer as the present 3.5-year Requirements contract. (The effect of DOE's offer of the modified ISC is discussed in more detail in Exhibit 7.)

3. Non-DOE suppliers of enrichment services have large excess capacity and are competing vigorously for the available market. Moreover, the USA is adding capacity and Japan is planning to do so. National nuclear power programs continue to fall well short of planned levels, so there is no possibility that the world's enrichment capacity could be fully utilized during this century. If DOE succeeds in retaining the US market, it will do so at the expense of Urenco, Eurodif and Techsnabexport.

Competition in worldwide SWU markets, and especially in the US market, has become a central concern of the enrichment services industry. A secondary market has developed with prices well below those the Department of Energy (DOE) charges primary customers. Utilities have, accordingly, encountered a new situation. The secondary market provides competitive choices—something utilities have not previously had. Enriched uranium and/or SWUs can be purchased from both other US utilities and from non-US sources. As serving the consumer is a paramount concern, choices have to take account of economic opportunities, and those favor secondary market purchases.

A major problem, from DOE's point of view, are the numerous constraints which greatly inhibit its ability to adapt to market realities in a beneficial way. I will discuss those later..

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Secondary Market Causes, Nature and Responses

Worldwide SWU production capacity is at least double that needed to accommodate consumption. Coping with this situation obviously requires considerations of causes, effects, and long-term solutions rather than mere temporary fixes. At first all suppliers had been reluctant to revise their approach. However, non-US enrichers have begun to compete vigorously for sales in the primary market.

The secondary market consists of trading between users. A user may have an excess of inventory or uneconomical future commitments. Relief is needed. There is a price at which a certain class of buyers will find it more economical to utilize SWU from the secondary market than to take delivery under a primary supplier contract. Note that the secondary market arises out of a need for relief. Competition is not the same as that which exists between primary sellers.

In the US, the secondary market for enrichment services has been around since the mid-1970s, and it has developed because past production has been excessive. For years, it was characterized by assignments of excess commitments and the exploitation of various termination provisions in DOE's enrichment contracts. Only in the last two years has distress selling of excess inventories brought competition in the form of non-DOE origin SWUs into the US market. (Exhibit 8 discusses in more detail the sources of secondary market SWU supply and demand.)

Enrichment services transactions fall into two broad categories.

1. In a **SWU sale,** uranium in enriched form (called "enriched product") may be sold for cash. Enriched uranium may also be exchanged for an equivalent amount of natural uranium and cash sufficient to cover the associated enrichment services. Other combinations of SWUs and cash are possible in this type of transaction, which is called a deenrichment swap.
2. In a **SWU assignment,** contract obligations may be reassigned from one user client to another.

The most important difference between a SWU sale and a SWU assignment is that the latter requires DOE consent and the former does not.

Pricing in the Secondary Market

As in any market, secondary market pricing is ultimately determined by matching value to the seller and value to the buyer. But the SWU market does have some special conditions which play a dominant role in the matching of these values.

Strong driving forces may exist on the seller side. For example, a seller may have an inventory of utterly unnecessary enriched product, as in the cases of some utilities whose only reactors have been cancelled. Or the seller may have future contractual commitments that would be prohibitively expensive to terminate. Users are sometimes forced to purchase otherwise unneeded natural uranium to supply enrichment services contracts, even though those may only further aggravate an enriched uranium inventory problem. As uranium is a single purpose commodity, nuclear power utilities are the only end users. Thus, a seller must adjust prices to whatever that one class of customers will pay.

Not all secondary market SWU sellers have strong driving forces. However, those that need relief the most tend to be the most aggressive, and thus the price leaders.

Buyers' problems are simply economics. All nuclear power plant operators are covered by long-term contracts with primary suppliers. Those that buy on the secondary market do not do so out of concern for the availability of a primary source. Rather, they participate in the secondary market only because opportunities in that market are economically attractive.

Conditions in the USA are such that a SWU seller must offer a price that offsets the buyers' termination fee under DOE contracts and, in addition, justifies the cost of participating in a special transaction. Where non-US SWU sources are involved utility buyers may require additional incentives "to go offshore."

These considerations have resulted in sellers (European *and* US) offering DOE SWU in the United States at prices of approximately $95 per SWU for short-term delivery. Non-DOE SWUs are approximately $90. [*Ed. note: those prices have since changed to $85 for non-DOE origin and $115 for DOE origin, due to the effect of DOE's modified Interim Sales Contract, explained in detail in Exhibit 7.*]

I would like to emphasize for your consideration the manner in which secondary market SWU prices are locked into DOE primary market pricing formulas. Primary market system changes immediately reflect back into secondary market pricing. The same incentives have to be maintained to keep the secondary market viable. An example of this interlocking relationship was recently demonstrated as a result of DOE's July 25, 1983 offer of the ISC. The offer included a price concession of approximately $11 to 3.5-year Requirements Contract holders. Secondary seller prices dropped about the same amount in order to maintain a realistic market position.

Note that DOE's pricing strategy has to be carefully

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considered because of other, possibly unwanted effects. A secondary market price of $90 places prices near a threshold where 5-year Requirements Contract holders may find it economical to participate in the secondary market. Thus far buying activity has been dominated by 3.5-year contract holders; but lower prices may expand that into the 5-year contracts.

Primary Versus Secondary Market Pricing

Although a direct relationship exists between primary and secondary market pricing, it is important to recognize that the two pricing systems develop from different starting points. Each primary supplier—DOE, Eurodif, Urenco and Techsnabexport (of the USSR) has its own unique pricing formula. Cost, nationality, return on investment, accounting practices, currency exchange rates and other variables play a role. A primary market share will be only partially determined by price.

Moreover, for primary producers, changing prices as a reaction to secondary market conditions is a risky course. As a primary supplier offers more favorable terms to match secondary market conditions, the secondary market then adjusts accordingly to maintain viability. A self-defeating cycle sets in—like a dog chasing its tail.

For example, the possible removal of imputed interest from the cost recovery formula has recently been publicized. As that is reported to be approximately $35 per SWU, and deliveries even at current rates are of the order of 15 million SWUs per year, loss of revenue will be on the order of one-half billion dollars per year. The prices of all non-DOE SWUs used in the US the next few years will only total around $200 million, or less than half the revenue loss. Moreover, the loss of revenue from omission of imputed interest may go on for many years while the secondary market loss may be relatively short-term. This is one example of how and why overreaction to the secondary market may be costly. The recently modified Interim Sales Contract, discussed in Exhibit 7, constitutes another example.

DOE's Commercial Constraints

Several important constraints limit DOE's responsiveness to the competitive environment prevailing in the primary and the secondary SWU markets.

1. *Cost recovery formula*—DOE is required by law to recover full costs over a reasonable period of time. This means, in effect, that pricing is a "zero-sum game". Any loss of revenue, whether from termination fees, or lower prices, to one class of contract holders, eventually must be recovered from price increases to other classes of contract holders. Therefore, DOE price concessions to 3.5-year requirements contract holders can best be regarded as a redistribution of cost to the industry as a whole rather than a selective price decrease. (At present, DOE uses a 10-year rolling forecast as a reasonable cost recovery period.)

2. *Price inelasticity of demand*—The primary market demand for enrichment services is virtually price-inelastic. Lower primary market prices do not significantly shrink the market. Increasing market share by one supplier must result in loss of market share by a competitive supplier. Moreover, price reductions by one primary supplier are usually met by other suppliers' price reductions as each attempts to maintain its share. The SWU market is essentially a "zero-sum market". That, coupled with the zero-sum cost recovery problem, makes for difficult pricing strategies.

3. *National policy consistency*—United States policy generally favors free international trade, more competition and less monopoly, and strong adherence to anti-trust principles. Inhibiting importation of SWUs would conflict with free trade. Limiting clients to DOE supply strengthens monopoly. Constraint of trade by contract contradicts anti-trust principles. Even though DOE is a government operation, and thus exempt from laws governing private companies, these actions provoke a negative reaction from those in industry who believe actions by government businesses should not run counter to government policy. The anti-trust, anti-monopoly philosophy is deeply ingrained in the underlying business ethic.

4. *Utility cost accountability*—Authority for spending and accountability for costs result in a split of responsibilities. Government, that is the Congress and Administration, determine expenditures, technologies used, and accounting practices. Utilities, on the other hand, bear the ultimate cost of those decisions. Utilities have, therefore, a natural reluctance to accept conditions which leave no option other than total dependency on DOE. The secondary market is a limited option, but at least it is some option. It is a means of requiring economic discipline by DOE not otherwise available to utilities.

The Apparent Thrust of Recent DOE Policy in Response to Secondary Market Competition, and Probable Market Reactions

I have discussed at length market conditions and constraints. I will next discuss what appear to me to be the thrusts of DOE's competitive responses and how the market may react.

The *first* is to make price (the ISC and the modified

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ISC) and termination cost concessions (USEC) to selected classes of contract holders to bind them to DOE supply. Or looking at it another way, to eliminate competition from sources of non-DOE SWUs, both in the primary and secondary markets. Success will probably be limited for reasons suggested earlier—namely reluctance to forego competition and recognition that price concessions to one class of customer must be compensated by price increases to others.

The *second* is to restrict or eliminate imports of non-DOE SWUs. One part of that approach makes the price concessions conditional on customers' agreement to confine their secondary market purchases to DOE SWUs. Another part limits the proportions of DOE SWUs which may be purchased from the secondary market. The utility response will probably be mixed. An allegiance to DOE will cause some customers to accept that condition, since they would purchase only from DOE in any event. But other customers are concerned with what they regard as measures to lock them more securely to monopoly supply.

A *third* is to allow freer secondary trading of DOE SWUs by waiving termination penalties if SWUs ordered under one type of contract were replaced by DOE SWUs—but not for non-DOE SWUs. A probable consequence is an immediate rise in the price for DOE secondary market SWUs. Sellers would no longer have to price low enough to cover the buyers' previous termination cost. Much of what was formerly a penalty payment to DOE would go as a higher price to a secondary seller. The buyer could afford to pay more and maintain the incentive margin. DOE sellers would have more interest in selling. And, as buyers would not be burdened with larger termination penalties, they would be more interested in seeking offers. The net effect would be:

1. An increase in secondary market activity for DOE SWUs;
2. A two-tier pricing system under which DOE SWUs would sell at one price level and non-DOE SWUs at a much lower price level.

Future of the Secondary Market

Secondary markets develop with all commodities, as the devices by which excesses and deficiencies are brought into balance. A secondary market for excess enrichment services is not likely to be a short-term phenomenon.

A secondary market thrives on complexity. The greater the number of participants and the greater the number of contract types, the greater the incentives for doing something and the greater the number of interesting combinations that can be developed.

I have worked with the nuclear power utility business from its inception. Serving the consumer at the lowest practical cost has always been a major concern of utilities. But the events of the past few years have intensified that concern. Nuclear fuel buyers and managers are more aggressive than ever in seeking out situations which will result in lower electricity costs. The underlying DOE approach of inducing utilities to forego competition in return for price concessions obviously poses important policy questions for utility managers, Boards of Directors, and Public Utility Commissions. The crux of the matter is the question of short-term incentives for staying with DOE vs. the long-term risk of higher prices from a sole-source supplier. (Exhibit 6 raises a number of issues concerning future SWU prices.)

Much of the imbalance which has created the secondary market has only been slightly relieved; the numbers of possible contractual combinations appear to be increasing; and utility participants are making aggressive efforts to achieve cost savings. I foresee, as a consequence, a secondary market continuing for years.

Conclusions and Suggestions

The secondary market is a result of imbalance in the nuclear fuel supply industry. A secondary market is a symptom, not a cause. A primary supplier aiming to stifle the secondary market will, if successful, only defer and increase imbalances. Those must then be dealt with at some time in the future when the problem has grown even larger, and therefore with severe consequences. It is far better to relieve stresses as they occur rather than to force their accumulation. One seldom gains by insisting on more of the medicine that first made the patient ill.

At present, sales of non-DOE SWUs on the secondary market are claiming only about 12% of US users' enrichment needs. A similar proportion is probable for the next few years. A built-in buffer exists discouraging a major enlargement. The most vulnerable contracts, the 3.5-year Requirements contracts, are limited. Penetrating the next most vulnerable class, the 5-year Requirements contract, is more difficult because termination penalties are higher. And beyond that are the most difficult of all, Adjustable Fixed-Commitment contracts. The secondary market has to confront that self-limiting feature.

A certain stratification exists with utility buyers. Some view their primary responsibility as one of economics, whether that means domestic or foreign buying. Others are committed to domestic buying regardless of other options. Those buyers will always be the first to accept an offer of concessions on price, terms, and conditions in return for stronger dependence on DOE supply. Those concessions would entail substantial cost to DOE, but very little cost to the utility already firmly committed to domestic supply.

The real target of DOE is the client willing to buy from non-US sources. Terms are designed to bring him under tighter control. If the incentives offered are less than needed to attract that client, DOE may suffer a net loss. The already-committed client will have accepted the preferred concessions, but the uncommitted clients may remain uncommitted, and thus, open to secondary market purchases. The net result may be a loss to DOE.

In my view--one more shaped by commercial than government experience—DOE's overriding competitive concern should be with the competition from other *primary* suppliers. And conversely, those competitive primary producers should be most concerned with competition from DOE. The secondary market is a rapidly moving target. Primary suppliers attempting to follow that relatively small but short-cycle market will erode the basic price structure for the larger, more important, long-term primary market.

The secondary market will continue to be driven by the need to sell excessive primary production. In addition to already existing inventories, already contracted supplies worldwide will outstrip consumption by 16 million SWUs over the next 5 years and by 6 million SWUs in 1983 alone. This will create the need to transfer some 3 million SWUs per year through the secondary market unless existing contracts are rationalized and production is curtailed. While most of the excess supply will be delivered to utilities outside the USA, US utilities already hold enriched uranium inventories representing a *surplus* of more than 5 million SWUs.

Unfettered, the secondary market will correct imbalances as they occur. A strategy designed to hinder the functioning of the secondary market hinders exactly that free market mechanism which is solving the fundamental problem. Ultimately, the primary supplier that best serves the interests of users while maintaining financial health will weather the competition best.

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EXHIBIT ONE

SUMMARY OF DOE SWU CONTRACTS

This article reviews the principal terms and conditions of six types of US Department of Energy (DOE) enrichment services contracts.

1. Requirements (two types);
2. Short-Term Fixed-Commitment (STFC);
3. Adjustable Fixed-Commmitment (AFC);
4. Draft Facility Requirements (FR);
5. Interim Sales (ISC).

Requirements Contracts

Requirements contracts, offered between 1968 and 1972, were the first so-called toll enrichment contracts offered by the US Atomic Energy Commission (now DOE). Their name is derived from the option customers have to take only their actual enrichment requirements from DOE. From the customers' viewpoint, the requirements contract is the best contract form ever offered by DOE.

Covering enrichment needs for the lifetime of a reactor, all requirements contracts expire between 1988 and 2012. Under the terms of the contract, the customer agrees, at least in theory, to purchase from DOE all SWU requirements for the reactor covered by the contract. However, the contracts' provisions for termination without charge after a relatively short minimum rolling period (free termination) make the *effective term* either 3.5 or five years (less if termination charges are paid), much shorter than the theoretical *maximum term* of thirty years. At the end of the contract term, the customer is free to use SWUs of any origin.

The contract feature most important to the secondary market is that providing for *free termination.* For any given year beyond the minimum rolling period, a customer may partially terminate a requirements contract; that is, to specify a zero SWU requirement. The requirements contracts first offered by the AEC specified a minimum rolling period of 3.5 years, while the later form increased the period to five years. Thus, the two types of contracts are commonly called **5-year Requirements** and **3.5-year Requirements** contracts.

During the minimum rolling period, when free termination is precluded, the customer may terminate by paying charges specified in the contracts. *Termination charges* are assessed as a percentage of SWU contract price and vary according to the amount of advance notice given.

Upon contract execution (or at least six months before the year of first delivery), DOE and the customer must have agreed upon the estimated annual enrichment requirements over the life of the contract, as documented in an appendix to the contract. Those estimated requirements (Appendix A), cumulated to the year of delivery, constitute the quantity ceiling above which the customer does not have to take and DOE does not have to provide required enrichment services. Adjustments to Appendix A can be made later upon mutual agreement of both DOE and the customer. As a practical matter, DOE customarily allows downward adjustments in the Appendix A requirements if the customer can demonstrate that the adjusted amounts will cover anticipated requirements. Unapproved or late adjustments may be subject to charges for partial termination. If the number of SWUs must be increased—that is, if the reactor's requirements are greater than anticipated—DOE usually will agree to deliver the extra SWUs, provided that the necessary production capacity is available.

Every year, on January 1 for US customers and on November 1 for non-US customers, the contract holder must provide a *non-binding notice* of estimated annual SWU requirements for the minimum rolling period (5 or 3.5 subsequent years). Under current practices, DOE also asks that customers provide estimates of their requirements for five to ten subsequent years. As part of the annual non-binding notice, the customer will also provide an estimate of the number of SWUs in every month of the two subsequent years. While the information provided by the customer is not contractually binding, the notice must include proposed dates for deliveries, allowing at least 90 days between feed deliveries, and withdrawals for the corresponding SWU deliveries.

At least 180 days in advance of SWU withdrawal, the customer issues to DOE a *binding notice* of the final number of SWUs, assays of feed and enriched product, and feed product quantities for a specific delivery. (The maximum enriched product and minimum feed assays must be within the assays specified in the DOE Standard Table of Enriching Services.) This is called a "firm-up" statement in that the 180-day notice becomes binding and may only be eliminated by termination (at a substantial charge) prior to SWU withdrawal. The transaction tails assay under the DOE on 180 days notice. Requirements assay under the Requirements contract is 0.2 percent, subject to change by DOE on 180 days notice. (Requirements contracts do not offer the variable tails assay option.)

Table 1 shows the termination charges associated with various notice periods for the two different types of requirements contracts.

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Table 1

TERMINATION CHARGES UNDER REQUIREMENTS CONTRACTS
(Percent of SWU Price for Terminated SWUs)

Notice (years)	5-Year Requirements	3.5-year Requirements
0-1	40 percent	25 percent
1-2	40 percent	20 percent
2-3	40 percent	15 percent
3-3.5	40 percent	10 percent
3.5-5	40 percent	0 percent
over 5	0 percent	0 percent

Another important feature of the requirements contracts is the inclusion of a *price ceiling*. The price for SWUs under this type of contract may not exceed a base price adjusted for escalation in power and labor costs (.75 x Power Index + .25 x Labor Index). During the 1970s, it was not uncommon for the ceiling price to be lower than the full cost recovery price. However, for the past few years, the ceiling price has not been limiting.

Payment for the delivery of SWUs must be made within 30 days of the DOE invoice date. This term was extended to 60 days for those holders of 3.5-year requirements contracts that accept the ISC offer except for deliveries in August and September 1983. Requirements contract *prices* (currently $149.85 for both 5-year and 3.5-year contracts) have usually exceeded AFC contract prices, but there is no apparent relationship between them.

Fixed-Commitment Contracts

The first fixed-commitment contract offered by DOE was the **Long-term Fixed-commitment (LTFC)** contract. While a few such contracts still exist, the LTFC contract is no longer a significant factor in the market for enrichment services.

The **Short-term Fixed-commitment (STFC)** contract, offered for 10 months in 1974-75, was developed as a companion contract to the LTFC. Originally intended to allow fabricators to purchase small amounts of enrichment services, DOE later broadened its policy to allow the use of the STFC in all contracting situations unsuitable for a long-term contract. The STFC was subsequently used as the foundation for the Interim Sales Contract recently offered to 3.5-year Requirements contract holders.

The **Adjustable Fixed-commitment (AFC)** contract replaced the LTFC contract in the late 1970s. It was DOE's response to customers' pleas for relief from excessive enrichment obligations caused by cutbacks in their nuclear programs.

In late 1982, DOE released the draft of a new contract form, the **Facility Requirements (FR)** contract. The revised version, unissued as of this writing, is to be entitled the **Utility Services enrichment contract (USEC).** Although reported to be completely different from the FR draft, it is more likely that the USEC will be similar in many respects when issued.

Numerous contract provisions are common to the STFC, AFC, and FR (draft) contract types.

1. The customer must define the proposed month(s) of delivery at least **314** days in advance. The customer may also request specific delivery dates within the delivery month(s).
2. DOE must notify the customer of the firm date(s) of delivery at least **240** (**275** in the FR draft) days prior to the beginning of the delivery month(s).
3. At least **180** days in advance of the firm SWU delivery date(s), the customer must specify the final quantities and assays (maximum enriched product and minimum feed assays to be within the assays specified in the DOE Standard Table of Enriching Services) of feed and product to be delivered.
4. A load-leveling provision allows DOE to alter delivery dates by up to two months, based on the values of three ratios calculated monthly. (The ratios relate to the distribution of DOE's scheduled SWU production over the six months preceding scheduled delivery.)
5. DOE may increase the 314, 240, and 180-day periods when the calculated ratios of monthly average demand exceed certain limits for an estimated month of delivery.
6. Feed deliveries to DOE must precede related SWU deliveries by 90 to 180 days as DOE may elect.
7. The price is the DOE fixed-commitment price in effect on the date of delivery.
8. Termination charges applicable to fixed-commitment type contracts are published in the Federal Register and revised periodically.

Termination Charges

The termination charges for fixed-commitment contracts (FC) are determined as percentages of the price of all terminated SWUs as of the date DOE received the termination notice. These percentages depend on the lead time given and the fiscal year the notice is given. These termination charges usually preclude secondary market purchases.

The termination charges for fixed-commitment contracts are reported in the Federal Register. Table 2 shows the charges reported in the notice dated November 28, 1980. A minimum charge is due, even if the number of SWUs affected by the termination of a given year's deliveries is zero. The minimum termination charge is equal to (0. 2 N P), where N is the number of years terminated and P is the sum of prepayments due or effected for each gross MWe of contracted plant capacity. For those contracts which required no prepayment, P is set at $3,300/MWe.

Table 2

TERMINATION CHARGES FOR DOE FIXED-COMMITMENT CONTRACTS

Advance Notice Period (Years)	Termination Charge (Percent of SWU Price) if notice is received in FY				
	83	84	85	86	87+
0.0- 0.5	51.5	47.5	43.2	38.6	33.5
0.5- 1.5	43.9	40.0	35.7	31.0	26.0
1.5- 2.5	36.9	33.0	28.6	24.0	19.0
2.5- 3.5	30.5	26.5	22.2	17.5	12.5
3.5- 4.5	24.5	20.5	16.2	11.5	6.5
4.5- 5.5	18.9	15.0	10.7	6.0	1.0
5.5- 6.5	13.8	9.9	5.6	0.9	0.0
6.5- 7.5	9.1	5.1	0.8	0.0	0.0
7.5- 8.5	4.7	0.6	0.0	0.0	0.0
8.5-10.5	0.7	0.0	0.0	0.0	0.0

STFC

The STFC contract is a short-term, take-and-pay contract. It must be executed no more than two years in advance of the DOE fiscal year of first delivery, but at least 180 days in advance of the month of first delivery. The STFC contract has a maximum term of 3 years, but may also be limited to just one SWU delivery, in which case the secondary market may be more advantageous. At time of execution, the customer and DOE agree on an enriching services schedule (Appendix A). This schedule defines the number of SWUs to be delivered in **each year** of the contract. At time of contract execution or at least six months prior to the fiscal year of first delivery, the customer must provide the estimated quantities of feed and assays of product (and notice of intention to use any enriched feed) to be delivered **each month** of the two subsequent years. This information is documented in another appendix (Appendix B), but is not contractually binding. Actual deliveries are firmed up by written notice 315 days in advance.

Adjustable Fixed-commitment (AFC) Contract

DOE introduced this type of contract in 1978 to replace the Long-Term Fixed-Commitment (LTFC) contract. The two contracts are essentially identical but for two major exceptions.

1. The rolling delivery period to be specified by the customer was reduced from 10 to 5 years.

2. Within the rolling period, DOE granted more flexibility with respect to the number of SWUs delivered in a given year and on the tails assay.

The AFC contract may be executed for a minimum period of 10 years and a maximum period to the lifetime of a reactor unit. Execution of the contract must be 6-10 years before the fiscal year of first delivery. An advance payment of $4,656 (possibly a different sum if a contract was executed after 1979) per estimated generated MWe is due in two installments. The first installment ($6000 per MWe) is due upon contract execution. The second installment (balance minus interest on first installment) is due 6 years prior to the first fiscal year of delivery. The prepayment accrues interest and is later applied against the first balance(s) due for the services provided. Additional payments, if any, are to be made within 30 days of the DOE invoice date.

Annual SWU requirements are firmed-up on a five year rolling period. Since the commitment for the fifth year is provided 15 months in advance of the first year of the five year rolling period, the contract actually contains six years of firm commitments documented in Appendix A. There are, however, some allowances for quantity flexibility. The fifth year of the rolling five year period is subject to +/-20 percent flexibility in the SWU commitment, and the fourth year is subject to +/-10 percent. Total quantity variation exercised for both years may not exceed +/-20 percent. The appendix also requires non-binding estimates for the five years following the fifth year of the rolling period.

Included with its annual submissions, the customer must provide estimates of tails assays corresponding to the Appendix A SWU commitments. In addition, estimated *monthly* quantities and assays for the subsequent three-year period must be given.

As part of the AFC contract, the customer may elect the variable tails assay option (VTAO) at least 15 months

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prior to the fiscal year of withdrawal. The VTAO allows the selection of tails assays between 0.16 percent and 0.30 percent. DOE may assess an efficiency loss penalty for tails assays below 0.2 percent, but the penalty has never yet been applied. This information is contractually binding. (Exhibit 3 discusses the secondary market effect of the VTAO in some detail.)

The AFC contract contains two mechanisms by which a customer could obtain relief from excess SWU commitments. Prior to firming up the appendices, a customer could *delay* the initial delivery period (the first 5 years of commitments) as many times as needed for up to 5 cumulative years, paying one-fifth of the advance payment for each year delayed. Delay was the less expensive of the two mechanisms and was exercised by several utilities.

The second relief provision was the *deferral* option. Under this provision, upon 15 to 47 months advance notice, the customer can defer a delivery (and all succeeding deliveries) up to 5 years each time, as many times as needed. The charge for deferral is the difference in discounted cash flows resulting from the schedule adjustment. The discount rate to be used in the analysis is that in effect at the time of election as determined annually by DOE. The SWU price is the fixed-commitment price in effect at the time (currently $138.65).

Another important feature of the AFC contract is the substitution provision. When the customer specifies his SWU commitments for the fifth year of the rolling period, he may elect to reduce his requirements by the use of other DOE-enriched material (from his inventory or the secondary market). In effect, this option is available on a 6 1/4 year lead time. An active assignment market existed for several years as utilities reduced expected excess inventories through this mechanism.

Facility Requirements (FR) Contract (Draft Of August, 1982)

The draft Facilities Requirements (FR) contract offered DOE customers more flexibility, but at the cost of stronger penalties for contract terminations. DOE plans to release later this year a second version containing such drastic changes that it has been given a new name: the Utility Services Enrichment Contract (USEC).

The FR contract draft differed from the AFC contract in four important respects:

1. Reduced advance payments;
2. Shorter committed rolling period;
3. Heavier penalties for contract termination, such as full payment of estimated number of SWUs for a period of up to 10 years in the worst case.
4. Requirements could be reduced through substitution of material originally enriched by DOE (like that in the AFC contract) upon an advance notice of 30 months prior to the beginning of the year of delivery.

Interim Sales Contract

It had become possible for holders of 3.5-year Requirements contracts to achieve substantial savings by participating in the secondary SWU market. The mechanism used was the partial termination of the contract. Even after paying the DOE termination charges (10-25 percent of the contract price per SWU), these buyers could buy secondary market SWUs to replace their terminated DOE deliveries and save enough money to justify the effort. Following private negotiations with at least two utilities, and after some hesitations caused by legal and policy questions, DOE offered the Interim Sales Contract (ISC) to all holders of 3.5-year requirements contracts.

The ISC is essentially a STFC contract modified to reflect a special 60-day payment term and 180-day notice on quantities and assays of feed and enriched product. It offers any 3.5-year Requirements contract holder willing to waive the right to terminate and agree to take all FY83-85 SWU requirements from DOE a price reduction of approximately $11.20 per SWU. It reduces their price for FY83-85 from the Requirements contract price (currently $149.85) to the fixed-commitment contract price (currently $138.65). It also doubles the payment term from 30 days to 60 days (except for deliveries that took place in August and September 1983). Although no termination for FY83-85 SWUs is allowed after a DOE customer accepts the ISC, its net commercial effect has been to reduce the break-even price from $112.39 to $101.19, and correspondingly to reduce the secondary market SWU price.

EXHIBIT TWO

DEVELOPMENT OF THE SECONDARY SWU MARKET

Introduction

The secondary market for enrichment services has undergone a fundamental change during the past one to two years. From a limited market characterized by

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assignments of Fixed-Commitment contracts from one US DOE customer to another, it has begun to develop into a truly worldwide secondary market. During 1982, utilities began making use of the secondary SWU market as an integral part of their overall fuel procurement strategy, much as they have been using the spot uranium and conversion markets. Many have expressed hope that the secondary market will remain active for the long term.

Many of the factors driving this market are the same as those driving the U_3O_8 and conversion markets. Overoptimistic demand projections, contracting far in advance of need, reactor cancellations and deferrals, supply overcapacity, inventory accumulation, and high carrying costs combined to produce in many market participants, utilities, in this case, a strong desire to sell their excess inventories. This article will review how the secondary SWU market developed to this point, and comment on how this new market may be affected by future events.

Early Development of the Secondary SWU Market

It was the introduction of the AFC contract combined with DOE's reopening of the order books that first created an active secondary SWU market. DOE chose to provide contract relief to customers through liberalized schedule adjustment provisions when LTFC contracts were converted to the AFC form under the July 1, 1978 option. Some DOE Fixed-Commitment customers suddenly found themselves able to seek new supply for years when others less fortunate were still stuck with excess commitments. DOE's policy allowing customers to reduce the amount of SWUs taken directly from DOE by the same amount of DOE SWUs obtained on the secondary market was used extensively to the apparent advantage of both buyers and sellers as new schedules of commitments were drawn up. As reactor cancellations and deferrals increased the excess of SWU supply, new demand entered the market with the signing of new DOE contracts. Thus, some of the new contracts could be partially filled by assignments of other utilities' excess SWUs.

The discounts available for secondary market transactions (assignments from one holder of a US DOE fixed-commitment contract to another) during the 1978-1979 time period were in the range of $2 to $5 per SWU for all fiscal years. This would seem to indicate that the market supply and demand were approximately in balance. However, the level of discounts was misleading. The market was in its infancy, there was little market information available, and the level of sophistication among market participants was low. Almost all accepted the transactions that were brought to them without argument, apparently feeling that they would be unable to complete the required contracting and interface with DOE without outside assistance.

As the market has developed, market participants' increasing sophistication and the better information produced by open competition in the marketplace have reinforced one another. Discounts have become more representative of market factors, such as the amount of DOE termination charges and the balance of supply and demand, instead of being determined arbitrarily in the absence of adequate information.

The Variable Tails Assay Option (VTAO) also facilitated the development of the secondary SWU market. Falling U_3O_8 prices made the higher tails assays available under the VTAO more valuable than the 0.20 percent tails assays mandated under Requirements contracts.

The first signs of the factors which would be responsible for the sweeping changes in this market environment became evident by the beginning of 1980. By that time, most schedule adjustments and conversions to AFC contracts had already been completed. As the market for new reactor orders had virtually ground to a halt, very few new enrichment contracts were being signed. Thus, the demand for short term SWU dropped dramatically and the primary customers for assignments of US DOE AFC SWUs withdrew from the market.

In order to stimulate new demand, sellers increased the discounts they were offering. At the same time, the continual reactor construction delays fed more and more new short-term supply into the market. A number of short-term sellers, frustrated in their attempts to sell, eventually began actively soliciting buyers. A few short-term *buyers* who had become sophisticated enough to perceive their market advantage decided to seek supply through open bidding.

Those buyers were able to obtain discounts of more than $20 per SWU through such open bidding. These transactions were widely reported, and other buyers began demanding and receiving similar discounts. Since then, open bidding by buyers and sellers has become the rule in the secondary SWU markets, just as in the uranium and conversion markets.

Still, through 1980, the secondary SWU market was characterized almost completely by sales from one DOE fixed-commitment customer to another. It was far from a true spot market. During that period, standard utility practice called for buyers automatically to contract well

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in advance with DOE for enrichment services sufficient for the entire life of a planned project. Most buyers looked on the secondary market only as a tool to assist them with that function.

Many buyers soon found themselves reentering the market as sellers due to their having bought new long-term commitments on the secondary market for reactors that were soon thereafter delayed further or cancelled. Although contract assignments had helped to relieve the SWU supply-demand imbalance *temporarily*, the continuation of apparently conservative purchasing practices had caused the SWU supply-demand imbalance to worsen in the *long term*.

Development of the Market During 1981-1982

Continued reactor delays aggravated the short-term oversupply of SWU on the secondary market. The more open exchange of information in the secondary market enabled it to respond in classic fashion—prices dropped, in the form of discounts greater than $30 per SWU from DOE's AFC price. During 1981, the discounts reached a level that made it profitable for certain DOE customers (holders of DOE Requirements contracts having 3.5-year termination provisions) to terminate both short-term and long-term commitments and buy replacement DOE Fixed Commitment SWU on the secondary market.

At first, buyers were only willing to terminate after they had already found replacement SWU on the secondary market. Some buyers would try to terminate only a current delivery, in effect terminating their requirements contract on a year-to-year basis for a relatively small monetary gain. Other buyers terminated long term, in effect choosing to exchange the flexibility of the requirements contract for the increased savings made available by the fact that DOE termination charges decrease with time. Several distinct stages of market development were evident:

1. Near the end of 1981 and continuing into 1982, some of DOE's *overseas* customers holding requirements contracts with 3.5-year termination provisions began terminating some of their SWU requirements scheduled for delivery 18 to 24 months later and replacing them with attractively discounted SWUs from other sources, such as Eurodif or Techsnabexport.

2. Later in the year, some of DOE's *US* customers holding requirements contracts having 3.5-year termination provisions began terminating some of their SWU requirements scheduled for delivery 18 to 24 months later and replacing them with SWUs from LTFC or AFC contracts. In both this case and the previous one, sellers terminating their DOE SWU contracts acted simultaneously to effect any necessary replacement, so as to accept zero risk of supply.

3. The next phase in the development of the secondary SWU market saw both US and overseas DOE customers holding requirements with 3.5-year termination provisions begin terminating their DOE commitments with very short notice, 6-12 months, and replacing them with highly discounted AFC SWUs from another DOE customer. As sellers of excess AFC SWUs had filled demand from potential buyers who were willing to terminate their requirements contracts with relatively long notice periods, and the correspondingly modest termination charges, the selling had become more difficult. In order to stimulate more demand, those same sellers raised discount levels even further. The highest discounts enabled buyers to execute a risk-free transaction and still make a profit, even after paying the higher termination charges associated with short notice.

4. Eventually, however, and importantly for the development of the market, in 1982 a number of US buyers, having done such a transaction once or twice, became willing to terminate DOE requirements contracts to contract for replacement SWUs only when their actual requirements become known, counting on the secondary market as a later source of supply.

Meanwhile, European buyers' enriched uranium inventories were continuing to increase due to contractual overcommitments to primary suppliers in Europe, which were almost three times actual expected reactor requirements of the customer utilities. European sellers began approaching US DOE customers, but initially with no success. There was still a large amount of DOE SWUs available on the market, although at a slightly lower discount, and taking foreign SWUs was initially perceived by US utilities to be too great a risk.

By the end of 1982, however, the flood of new Requirements contracts buyers had used up almost all available DOE secondary market SWUs for short-term delivery at high discounts. There were not enough secondary market DOE SWUs available to meet the demand for those Requirements contracts holders who had not yet terminated 1983 deliveries and wished to do so. The attempts to sell Eurodif SWUs in the US began to meet with some success. Buyers either had to stay with the Requirements contracts, or purchase non-DOE SWU. A number made the decision to purchase foreign SWUs.

The new DOE Facility Requirements (FR) contract, introduced during 1982, is the largest uncertainty in the secondary SWU market. Termination charges under the FR have been designed to be prohibitive, so that wholesale conversion to the FR would virtually eliminate

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US DOE customers as potential buyers of non-DOE secondary market SWUs. However, DOE has not yet announced the terms and conditions of conversion to the FR, such as the range of schedule adjustments which will be allowed and the costs thereof. Those terms and conditions will help shape the future development of the market.

Future Development of the Market

The secondary SWU market is beginning to be viewed by at least some participants as a true spot market, another tool to be used along with long-term contracting as part of an overall strategy to minimize fuel costs. Whether the market will indeed develop to the point of being widely used for this purpose depends upon SWU supply for the long term remaining available on the secondary market.

Worldwide enrichment capacity will exceed expected reactor requirements far into the future. The critical question is whether this excess capacity will be translated into excess commitments that find their way to the secondary market.

The introduction by DOE of the FR contract constitutes the most serious threat to the long-term continuance of a strong secondary SWU market driven by excess DOE commitments. The FR contract's two-year rolling firm commitment period (as against the AFC contract's five years) indicates that, should most AFC customers convert as expected, the quantity of excess DOE SWUs available in the secondary market will diminish drastically. Some excess commitments will continue to exist due to unexpected reactor delays, but customers will not be faced with the possibility of building up years of unneeded inventory for a reactor that has not yet begun to operate. Therefore, the economic incentive to sell on the secondary market as against simply buying and holding inventory will be reduced substantially.

On the other hand, the continued buildup of enriched inventories in Europe, caused by the overcommitments of the various Eurodif partners, strongly implies that a large surplus of non-DOE SWU will become available for sale long-term on the secondary market. The vast majority of potential buyers remain the DOE 3.5-year Requirements contract holders. The vast majority of these DOE customers are in the US so they effectively dominate the buy side of the market. Conversely, European holders of excess SWUs will control the sell side of the market.

Whether the secondary SWU market remains active for the long term, as many active buyers hope, or instead proves to be a short-term anomaly, depends primarily on the acceptability of non-DOE SWUs to those same US buyers. At present, it appears that most US buyers, while still preferring DOE secondary market supply, would much rather take the perceived risk of buying foreign SWUs than give up the economic advantages of participating in the secondary market all together. The next significant market development could easily be the termination, both with short notice and longer term, of DOE requirements contracts and their replacement with non-DOE SWUs for the longer term.

EXHIBIT THREE

THE VARIABLE TAILS ASSAY OPTION: ITS SIGNIFICANCE TO THE SECONDARY SWU MARKET

Nuexco's brokerage experience indicates that the availability of the VTAO has encouraged the existence of an active secondary SWU market. The VTAO has had the following commercial effects:

1. It has effectively reduced the economic penalty of selling SWUs. Without the VTAO, some utilities having excess SWU commitments would decide simply to hold enriched uranium inventory. Having the option to vary their tails assay, those same utilities now find it economic to sell at the somewhat lower discounts necessary to complete a transaction at a higher tails assay.
2. It has enabled more utilities holding DOE requirements contracts to obtain the effective discounts necessary to terminate economically and buy replacement DOE SWUs on the secondary market.

An example will illustrate the use of the VTAO to facilitate a secondary market SWU transaction:

1. Utility A, wishing to dispose of excess SWU commitments, has elected a tails assay for its fiscal year 1983 (FY83) deliveries of 0.28 w/o (weight percent) under the VTAO.
2. Utility B, holding a 3.5-year termination Requirements contract, decides to terminate partially its minimum expected requirements for FY83 of 100,000 SWUs and buy the replacement SWUs from Utility A. Utility B pays DOE a termination charge of $37.46 for each SWU terminated (25 percent of the requirements contract price, $149.85 per SWU).
3. Utility B, just to break even, must therefore receive an effective SWU price of $112.39 per SWU ($149.85 - $37.46).

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4. In order to have some incentive to complete the transaction, Utility B decides it needs an additional discount of $3 per SWU, or a price of $109.39.

5. Therefore, if utility A were selling SWUs at a tails assay of 0.20 w/o, Utility A would need to offer a discount of $29.26 off the Adjustable Fixed Commitment (AFC) price per SWU ($138.65 - $109.39).

Since utility A is offering 0.28 w/o tails rather than .2 tails, however, the discount offered will be significantly less than $29.26, depending on the enriched product assay Utility B wants, as well as the marginal cost of UF_6 feed. *Note that Utility B's historical cost of feed does not affect the calculation, only the marginal cost of buying additional feed (in place of SWU) on the open market.*

Assuming that Utility B wants an enriched product assay of 3.4 percent, and that the marginal cost of feed in the spot market is $48 per KgU, the discount offered by Utility A could be calculated as follows:

1. Calculate the amount of enriched product Utility B wants, as well as the quantity of SWUs and natural feed required at .2 tails.

100,000 SWUs at .2 tails will produce 100,000/5.19 or 19,268 KgU as 3.4 percent enriched UF_6, and requires 19,268 x 6.26 or 120,618 KgU as natural UF_6 feed.

2. Calculate the quantity of SWUs and feed that would be required at .28 percent tails assay.

19,268 KgU at 3.4 percent enrichment with .28 tails requires 19,268 x 4.32 or 83,238 SWUs and 19,268 x 7.24 = 139,500 KgU feed.

3. Calculate the cost of 19,268 KgU at 3.4 percent enrichment with .2 w/o TA.

100,000 SWU x $109.39 per SWU ($138.65-$29.26) +
120,618 KgU feed x feed price ($48 per KgU feed) =
$16,728,664.00

4. In order to calculate the SWU price (SP) at .28 TA that would be equivalent to a discount of $29.26 at .2 TA, set the cost of product at .2 TA equal to the cost of the *same amount* of product (19,268 KgU as UF_6) at .28 TA.

5. Thus, at .28 TA, the cost of 19,268 KgU as 3.4 percent enriched UF_6 would be calculated as

83,237 SWU x SP in $ per SWU +
139,500 KgU feed x feed price ($48 per KgU feed) =
$16,728,664.00

6. Thus, 83,238xSP = $10,032,664
so, SP = *$120.53*

Solving for SP indicates that a price of $120.53 per SWU at .28 tails offered by Utility A will be effectively equivalent to a SWU price of $109.39 at .2 tails. So utility A only would need to offer a discount of $138.65 - $120.53, or $18.12 per SWU to complete this transaction.

EXHIBIT FOUR

INTERIM SALES CONTRACT: EFFECTS ON SECONDARY SWU MARKET PRICING AND DEMAND

Having discovered that some DOE customers (holders of Requirements contracts containing 3.5-year termination provisions) could save substantial amounts of money by partially terminating their DOE contracts, paying the DOE termination charges (10 to 25 percent, as opposed to 40 percent for contracts having 5-year termination provisions), and replacing those SWUs on the secondary market, DOE responded with the Interim Sales Contract (ISC) to induce them to forego the secondary market opportunity.

At a time when $1.8 billion already had been spent on the new Portsmouth centrifuge plant, DOE had lost about $1 billion worth of business through SWU contract terminations, and $470 million were still at risk over the next three years under contracts with nine customers. In the first of several tactics planned "to try and rationalize the market", DOE needed to offer prices which, given the current termination charges, would eliminate any significant incentive for a DOE customer to turn to the secondary market. Following negotiations with Philadelphia Electric Company and after some hesitations caused by the legal issues, DOE offered the ISC to all holders of Requirements contracts having 3.5-year termination provisions. Under the ISC, a DOE customer would waive the right to terminate the contract and would commit to take all enrichment requirements from DOE. In return, DOE would reduce that customer's SWU price for FY83-FY85 (currently $149.85) to the fixed-commitment contract price (currently 138.65) and increase their current 30-day payment term to 60 days.

The secondary market price for SWUs dropped by $8 as a direct consequence of DOE's offering of the ISC. With a 25 percent termination charge, currently $37.46, and a new secondary market price of $X, a utility willing to terminate a 3.5-year Requirements contract would end up paying $(37.46 + X) per SWU. Under the terms of the ISC, the same customer would pay only $138.65 per SWU (current fixed-commitment price). It is Nuexco's observation that, to give any utility some incentive to consider the secondary market, a profit of at least $6-7 should be possible. A mathematical translation of this statement is: (138.65) - (37.46 + X) must be greater than or equal to $6 to $7 or, X must be less than or equal to 138.65-37.46-($6 to $7) = $94.19 to $95.19. The inclusion of another $4-5 discount for SWUs of non-DOE origin

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would yield a secondary market price of approximately $90 for non-DOE SWUs.

The effect of the DOE's offer of the ISC has been to reduce the break-even price from $112.39 to $101.19, although no termination for FY83-85 SWUs will be allowed if the affected DOE customers decide to accept the ISC. Transactions unaffected by the ISC are all those that do not depend on a partial contract termination by a holder of a DOE Requirements contract having a 3.5-year termination provision. Those include:

1. DOE-origin/DOE-origin
2. Eurodif-origin/Eurodif-origin
3. Sales of DOE-origin SWUs to non-DOE customers.

Decisions by DOE customers holding Requirements contracts having 3.5-year termination provisions to accept or decline the ISC will be based on several factors.

1. By accepting the ISC, a customer would obtain a guaranteed saving ($11.20 per SWU for FY83, indeterminate for FY84 and FY85).
2. In exchange, that same customer would surrender the opportunity to obtain an even greater saving on the secondary market. Given the tremendous excess of secondary market SWUs, the course of action likely to yield the greatest benefit to shareholders and ratepayers is far from certain.
3. To the extent that a customer accepts the ISC in order to support DOE as their primary supplier of enrichment, that customer would be paying $6-$7 per SWU more than if they were bought on the secondary market.

The ISC's Impact on Secondary Market Demand

DOE's issuance of the Interim Sales Contract (ISC) lowered drastically the prices which sellers must offer to induce 3.5-year Requirements contract holders to terminate and buy replacement SWUs on the secondary market. The ISC could have caused secondary SWU market activities to come to a halt if it has been accepted widely by active buyers or if secondary market supply had diminished. However, sellers of large quantities of Eurodif SWUs, having no reactors in which to use their excess commitments, promptly lowered their offering prices in order to remain competitive.

As a result of sellers' lower offering prices, the demand for secondary market enrichment services for FY84 and FY85 delivery has returned to pre-ISC levls. Those 3.5-year requirements contract holders that signed the ISC, thereby withdrawing from the market, were in most cases not secondary market participants in the first place. The few formerly active secondary market buyers that have withdrawn had previously expressed strong interest in buying only DOE-origin SWUs. Thus, their withdrawal comes at the expense of those sellers of AFC SWUs (DOE-origin) that had been unwilling to offer the lower prices necessary to compete with the Eurodif suppliers.

DOE 3.5-year Requirement contracts cover 43 US reactors, 16 European reactors, and 8 Japanese reactors. A number of 3.5-year contracts had been partially terminated before the issuance of the ISC. Approximately 2 million SWUs for FY84 and 85 delivery had been terminated by US utilities, and 2.6 million SWUs for FY84 and 85 had been terminated by European utilities. Table 3 shows Nuexco's tabulation of estimated SWU requirements for those units still covered by the 3.5-year contracts at the time of issuance of the ISC.

Table 3

TOTAL SECONDARY MARKET POTENTIAL AT TIME OF ISSUANCE OF ISC (thousands of SWUs)

	FY84	FY85
USA	2,240	1,330
Europe	150	120
Japan	540	550
TOTAL	2,930	2,000

The requirements summarized in Table 3 represent total potential secondary market demand from the 3.5-year requirements contract holders at the time of issuance of the ISC. Actual secondary market demand was less. A number of potential buyers have political or other institutional reasons not to terminate and buy replacement secondary market SWUs, particularly of non-DOE origin. Table 4 and Table 5 show Nuexco's estimate of the secondary market potential of US and non-US buyers respectively at the time DOE issued the ISC.

As of October 1, 1983, three US utilities representing demand for 880 thousand SWUs for FY84 delivery and 260 thousand SWUs for FY85 delivery have either signed or are in the process of signing the ISC. Likewise, the Japanese customers of DOE holding 3.5-year Requirements

Table 4

SECONDARY MARKET POTENTIAL AT TIME OF ISSUANCE OF ISC: US UTILITIES WITH 3.5 YEAR CONTRACTS

(Thousands of SWUs)

Utility	FY84	(Origin Sought)	FY 85	(Origin Sought)
A	130	(DOE only)	—	
B	160	(DOE or Eurodif)	150	(DOE or Eurodif)
C	770	(DOE or Eurodif)	560	(DOE or Eurodif)
D	150	(DOE or Eurodif)	—	
E	220	(DOE)	210	(DOE)
F	360	(None specified)	50	(None specified)
G	390	(None specified)	—	
H	—		160	(DOE or Eurodif)
I	—		140	(DOE or Eurodif)
J	60	(DOE or Eurodif)	60	(DOE or Eurodif)
Total US	2,240		1,330	

Table 5

SECONDARY MARKET POTENTIAL AT TIME OF ISSUANCE OF ISC: NON-US UTILITIES WITH 3.5 YEAR CONTRACTS

(Thousands of SWUs)

Region	FY84	(Origin Sought)	FY85	(Origin Sought)
Europe	150	(DOE or Eurodif)	120	DOE or Eurodif
Japan	540	None	550	None

Table 6

SECONDARY MARKET POTENTIAL AS OF OCTOBER 1, 1983: US UTILITIES HAVING 3.5-YEAR CONTRACTS

(Thousands of SWUs)

Utility	FY84	(Origin Sought) (or Current Status)	FY85	(Origin Sought) (or Current Status)
A	130	(DOE Only)	—	
B	160	(DOE or Eurodif)	150	(DOE or Eurodif)
C	640	(DOE or Eurodif)	560	(DOE or Eurodif)
D	150	(DOE or Eurodif)	—	
E	220	(DOE)	210	(Signed ISC)
F	360	(Signed ISC)	50	(Signed ISC)
G	390	(Will sign ISC)	—	
H	—	160	(DOE or Eurodif)	
I	—	140	(DOE or Eurodif)	
J	60	(DOE or Eurodif)	60	(DOE or Eurodif)
TOTAL US	2,240		1,330	

Table 7

SECONDARY MARKET POTENTIAL AS OF OCTOBER 1, 1983: NON-US UTILITIES WITH 3.5 YEAR CONTRACTS

(Thousands of SWUs)

Region	FY84	(Origin Sought) (or Current Status)	FY85	(Origin Sought) (or Current Status)
Europe	150	(DOE or Eurodif)	120	(DOE or Eurodif)
Japan	540	(Expected to sign ISC)	550	

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contracts, representing 540 thousand SWUs for FY84 and 550 thousand SWU for FY85, reportedly intend to sign the ISC. No European utility has expressed interest in the ISC. Also, since the original offering of the ISC, one US utility terminated and bought on the secondary market 130 thousand SWUs for FY84. The current status is indicated in Tables 6 and7.

Only two US utilities that *previously had been in the market* decided to withdraw and sign the ISC. Their actions removed 130 thousand SWUs of FY84 demand and 260 thousand SWUs of FY85 demand from the secondary market for DOE SWUs. The remaining expected signees of the ISC had rejected previously the idea of terminating and buying replacement SWUs on the secondary market, despite the apparent economic advantages.

Potential buyers are continuing to participate actively in the market, confident that they will still be able to terminate their Requirements contract deliveries and buy on the secondary market from sellers of Eurodif-origin SWUs at a substantial economic advantage. Sellers of DOE origin SWUs also have been forced to drop their prices to compete.

EXHIBIT FIVE

THE IMPACT OF THE FR CONTRACT ON THE SECONDARY SWU MARKET

The driving force of the secondary SWU market has always been the need to dispose of excess DOE commitments. The long-term effects of the FR contract will therefore depend on the effect the new contract has on the amount of excess DOE SWU commitments. The short-term effects cannot be known until DOE announces the terms and conditions of conversion. The long-term effects, however, are apparent from a quick review of the contract's terms and conditions.

The FR contract contains a 2 year rolling firm commitment period rather than the 5 year period of the AFC contract. As a result, the amount of firm commitments made by customers to DOE will be drastically reduced. AFC customers, for example, were required on July 1, 1982, to specify firm commitments to DOE for FY 1988 if their contracts did not already contain such as part of an initial delivery period. Under the new FR contract, firm commitments for FY1988 in such a case would not have to be made until April 1, 1986.

If, as expected, most AFC customers choose to convert to the FR form, in the long run there will much less excess SWU that could be available for sale on the secondary market. Some excess commitments will continue to exist due to unexpected reactor startup delays and outages. But DOE customers will not be faced with the possibility of selling or possibly carrying unneeded inventory for 6 years or more. At most, a customer could be faced with 3 years of unneeded commitments. As a result, the economic attraction of selling as against buying and holding will be reduced. Therefore the discounts offered by potential sellers will be much less than at present.

On the demand side, the long-term effect of the FR contract will be to decrease secondary market activity. The FR contract states that DOE must be given 30 months notice if a customer is to reduce the amount of enrichment services taken from DOE directly by buying DOE SWUs on the secondary market. Under steady state conditions, there would be no FR contract holders with firm commitments that far ahead. Sellers would have to come from any remaining LTFC or AFC contract holders, or inventory holders who had not yet been able to sell material. Also, the attractiveness to the buyer of taking material on the secondary market is greatly reduced, since commitments to purchase on the secondary market would have to be made in advance of normal commitments made to DOE. It is questionable whether there would be any sellers offering discounts making it worthwhile for a secondary market buyer to accept this increased scheduling risk.

Requirements contract holders will most likely find discounts offered by DOE sellers to be too low to allow economic termination of Requirements contract deliveries and their replacement with secondary market SWUs. If such buyers are to continue their secondary market activity, they will most likely have to begin purchasing replacement SWUs from Eurodif sellers.

Under long-term equilibrium conditions following wholesale conversion to the FR contract, there would be little room for the existence of the traditional DOE customer-to-DOE customer secondary SWU market that exists today. Its most likely replacement will be a new secondary market driven by Eurodif excess SWU commitments, with the most likely buyers being the DOE customers with the old Requirements contracts containing 3.5-year termination provisions.

The short-term effect of the conversion to the FR contract on the secondary SWU market will depend on the terms and conditions of conversion, which DOE is expected to announce in the spring of 1983. [*Ed. note: the FR contract draft was never offered in final form but is expected to be revised in the as yet unannounced Utility Services enrichment contract (USEC)*]. There may be a

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short-term burst of activity, similar to that which occurred with conversion to the AFC contract. The immediate effect on the demand side would be to increase the number of potential intermediate-term buyers, due to the sudden shortening of the commitment period. Whether there will be many secondary market sellers to meet that demand will depend on the terms and conditions of schedule adjustment offered with conversion.

The draft FR contract was effectively repudiated by the market. Two major criticisms of the contract as proposed included:

1. the high termination charges that do not decrease with time;
2. the long lead time of 30 months required for assignments or substitutions of other DOE enriched material.

In addition, some DOE customers were dissatisfied with the FR contract concept completely and have requested that DOE simply return to offering the requirements contract form.

DOE's actions with regard to the conversion of existing contracts to proposed contracts are being watched very closely due to the dramatic effect a large scale conversion of AFC contracts to an FR-type form would have on the secondary SWU market.

EXHIBIT SIX

SWU POLICY ISSUES

Nuexco's review of trends in the enrichment services market has raised a number of issues concerning future SWU prices. This article will not attempt to resolve those issues. Rather, it will summarize some of the most important questions for the consideration of our readers.

Price Projections

Various government agencies have reported apparently conflicting projections for DOE SWU prices.

1. In June of this year, DOE issued a forecast of enrichment prices (in FY83 dollars) which showed a steady decline from the current $138 per SWU to about $112 in 1995. [United States Enrichment News, DOE, June 1982]

2. More recently, DOE issued an even more favorable forecast, with prices as low as $70 per SWU (in FY85 dollars) in 1995 declining to "about $50 SWU or less by the year 2000" if the Atomic Vapor Laser Isotope Separation (AVLIS) system meets expectations. ["New Enrichment Technology—What Can the Customer Expect?"; Fourth Annual Pacific Basin Nuclear Conference; Vancouver]

3. The Congressional Budget Office (CBO) has published an independent analysis, which agrees with DOE that the employment of either the advanced gas centrifuge or the atomic vapor laser technologies will result in lower enrichment costs in the long run (42 years). However, the CBO estimates average DOE costs for 1983-95 at *$230-$240 per SWU (in FY83 dollars).* [Nuclear Fuel; May 9, 1983]

4. The General Accounting Office (GAO), in a separate analysis of future DOE costs, has questioned the cost effectiveness of the Gaseous Centrifuge Enrichment Project (GCEP). Using DOE methods, but lower estimates of enrichment demand and power cost escalation, the GAO reports ". . . there are apparently no definite long-range cost reduction benefits associated with constructing GCEP. However, even if one accepts the position that building GCEP is economical, building the plant would not begin to reduce the average customer price for SWUs until after 1992." ["Issues Concerning DOE's Justification for Building the GCEP", GAO/EMD-82-88, May 25, 1982, and Supplement GAO/EMD-82-88S, June 24, 1983]

Question: As the Atomic Energy Act requires the full recovery of costs through revenues, what effect will the conflicting cost forecasts have on future DOE SWU prices?

Financial Analysis

As a result of the apparent conflict between the various government agencies on future DOE costs, it would seem worthwhile to investigate further the DOE cost structure. DOE prices are currently established on a complex system of cost accounts over a rolling 10-year period, and a complete analysis requires considerable effort. However, a cursory analysis of the 1984 DOE budget [United States Enrichment News, DOE, June 1983] indicates that further study is merited.

Total cash outlays in 1984, per the DOE budget, are $2.24 billion, or about $190 per SWU for the 12 million SWUs to be produced in 1984. After adding imputed interest and depreciation charges of $43 per SWU, the total cost of a SWU produced in 1984 appears to be $233, within the $230-240 range of the CBO's estimated average SWU costs for 1983-1995.

Conclusion

The actual price of future DOE enrichment services will be the result of complex calculations involving expected future costs and enrichment demand. In addition,

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past price projections may have given very conservative treatment to technological improvements. Thus, there may be legitimate reasons for the apparent discrepancies in future price projections. However, as DOE is required by law to obtain full cost recovery, its customers should develop a better understanding of the DOE cost structure prior to making significant decisions on future enrichment services.

The anticipated Utility Services enrichment contract will most likely require DOE customers to accept only DOE SWUs for the long term and forego opportunities to seek competing supplies from foreign enrichers. Whether it is in a utility's best interests (and those of its stockholders and ratepayers) to forego the long-term benefits of competition in return for near-term price concessions is an issue of fundamental concern to utility managers, their supervisors, and regulatory authorities. Answers to this question and others raised in this article will be important to those utilities facing SWU market decisions in the next few months. Not all parties are likely to arrive at the same conclusions.

EXHIBIT SEVEN

THE MODIFIED INTERIM SALES CONTRACT: EFFECT ON THE SECONDARY SWU MARKET

The secondary SWU market is reacting rapidly to the latest in the series of DOE efforts to stifle competition from sellers of Eurodif-origin SWUs. DOE has fundamentally altered the conditions of the secondary SWU market by modifying the terms of the Interim Sales Contract (ISC). Although Nuexco has not yet seen the contract itself (DOE officials say there are still a few details to work out), DOE has confirmed the contract's basic terms and conditions and that it is being offered to holders of 3.5-year Requirements contracts.

The new contract form is virtually identical to the original ISC (the so-called mini-deal), except that it allows the customer free substitution for purchases of some DOE—but only DOE—SWUs on the secondary market. Specifically, it allows the customer to purchase up to 40 percent of FY84 requirements and up to 60 percent FY85 requirements from secondary market sellers of DOE-origin SWUs without being assessed the customary termination charge. For FY84 SWUs, the savings to the customer amounts to almost $37.50 per SWU, based on 25 percent of the Requirements contract price ($149.85).

The DOE action will definitely hurt the sellers of non-DOE SWUs with most potential buyers that are now in the market. Potential buyers having 3.5-year Requirements contracts will find the DOE offer more attractive than offers of non-DOE SWUs at the current secondary market price of about $90 per SWU.

To purchase SWUs of non-DOE origin on the secondary SWU market at $90, a buyer terminating a DOE 3.5-year Requirements contract for FY84 would have paid a net price of approximately $271.50 ($90 to seller plus approximately $37.50 per SWU to DOE for the usual 25 percent termination charge). By accepting the revised ISC and buying 40 percent of its desired quantity from a seller of DOE-origin SWUs (at a price of $102), one market participant has been enabled to reduce its average cost to $124 per SWU, a savings of approximately $3.50 per SWU over the secondary market price, as indicated in Table 8.

In the example shown in Table 8, a secondary market price for non-DOE SWUs of $86.53 per SWU would have yielded the same average unit cost ($123.99) that the buyer actually paid by accepting the revised ISC and buying 40 percent of FY84 requirements on the secondary market. Table 9 shows, for several different second-

Table 8

POTENTIAL SAVINGS ASSOCIATED WITH MODIFIED ISC

	Quantity[1] (thousands of SWUs)	Price (US$/ SWU)	Cost (US$)
Option 1: Buy Non-DOE SWUS on on Secondary Market	200	90	18,000,000
DOE Contract Termination Charge		37.46	7,492,500
TOTAL			25,492,500
Option 2: Accept Modified ISC:			
Secondary Market DOE SWUs	80	102	8,160,000
ISC (same price as fixed commitment)	120	138.65	16,638,000
TOTAL			24,798,000

Option 1 - Option 2 = $694,500 = *$3.47* per SWU

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[1] For illustrative purposes, the table assumes a nominal quantity of 200,000 SWUs. Unit prices are independent of quantity.

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ary market prices for DOE SWUs, the secondary market prices that would make secondary market buyers indifferent between the cost of non-DOE SWUs and the cost of DOE SWUs.

Table 9

SECONDARY MARKET INDIFFERENCE PRICES

Secondary Market Price for DOE SWUs (US$/SWU)	Buyer's Average Cost per SWU (US$/SWU)	Equivalent Secondary Market Price for Non-DOE SWUs (US$/SWU)
100	123.19	85.73
102 (Table 8)	123.99	86.53
105	125.19	87.73
110	127.19	89.73
115	129.19	91.73
120	131.19	93.73

Thus, for a given secondary market price (SMP) for FY84 DOE SWUs the equivalent secondary market price (EP) for non-DOE SWUs is derived as follows:

1. EP = 60%(ISC price) + 40%(SMP) - Termination charge;
2. EP = 60%($138.65) + 40%(SMP) — 25%($149.85);
3. EP = $83.19 + 40%(SMP) — $37.46;
4. EP = $45.73 + 40%(SMP).

The necessary offering price would then be determined by subtracting the amount necessary to motivate buyers to accept non-DOE SWUs in preference to DOE-origin SWUs.

Prior to the announcement of the original ISC, holders of 3.5-year Requirements contracts needed to receive a price of $112.39 in the secondary market to offset their termination charges. Sellers of DOE SWUs needed to offer at approximately $108, while sellers of non-DOE SWUs needed to offer at approximately $100, to provide the incentive necessary to motivate buyers to action. Upon the announcement of the original ISC, the indifference price for 3.5-year Requirements contract holders dropped by $11.20, to the level of $101.19. Consequently, sellers of DOE SWUs reduced their offering prices to the range of $95-100 and sellers of non-DOE SWUs reduced their offering prices to approximately $90. Historically, secondary market sellers of non-DOE SWUs have had to offer discounts of approximately $10-12 per SWU in order to compete successfully.

Owners of excess DOE-origin SWUs are beginning to recognize the changes brought about by this new situation. Some have already raised their prices to the $115 level. We anticipate that more will do so. Secondary market prices for DOE SWUs presently fall primarily in the range of $110-115. Two factors have been significant in the establishment of that price range.

1. The large short-term supply of DOE-origin SWUs on the secondary market;
2. The recognition by DOE sellers that even at prices approaching $115, buyers that accept the modified ISC still can achieve considerable savings. Prices could move even higher but for the anticipated competition among sellers. At the $110-115 price level for secondary market SWUs of DOE origin, the buyer's indifference price for non-DOE SWUs is $89.73 to 91.73.

Holders of 5-year Requirements contracts are not being offered the modified ISC (just as they were not offered the original ISC), so their indifference price is a simple function of the Requirements contract price and termination charges. Allowing for a 40 percent termination charge yields an indifference price of 60% x $149.85 = $89.91, a figure that falls within the range of secondary market prices for non-DOE SWUs equivalent to secondary market prices for DOE SWUs in the range of $110-115. Thus, the secondary SWU market is approaching the point at which holders of 5-year Requirements contracts can be drawn into the market in large numbers.

Most 3.5-year Requirements contract holders that decide to accept the modified ISC naturally will want to contract for DOE SWUs on the secondary market to reduce their average costs below the DOE Fixed-Commitment contract price of $138.65. Having thus restricted potential secondary market purchases to SWUs of DOE origin, the potential buyer would become vulnerable to increases in the secondary market price for DOE SWUs. If the secondary market supply of DOE SWUs proved insufficient to meet demand, then the secondary market price for DOE SWUs could approach (or slightly exceed) the $130 level. Any greater price would remove the incentive to act, so that a price of approximately $130 should be regarded as a short-term ceiling on the price of DOE SWUs on the secondary market.

Therefore, utilities that plan to accept the revised ISC will wish to arrange their secondary market purchases for both FY84 and FY85 as soon as possible, perhaps even before accepting DOE's offer. In our opinion, secondary market sellers of non-DOE SWUs will also pursue actively the potential market for FY85. The secondary market price and availability of FY85 SWUs of non-DOE origin will be a factor in some potential buyers' decisions to accept or decline DOE's offer of the revised ISC.

In that case, if DOE prices for FY85 were unchanged from FY83-84, and assuming a $115 price for secondary market sales of FY85 SWUs of DOE origin, the equivalent secondary market price for non-DOE SWUs would become 40%($138.65) + 60%($115) - $29.97 = $94.4, the indifference price for FY85SWUs of non-DOE origin.

The modified ISC will certainly result in the sale of more DOE SWUs to 3.5-year Requirements contract holders for FY84 and FY85. But at what cost? For purposes of analysis, assume that DOE's offer of the modified ISC will prevent the termination of 2 million FY SWUs. That means DOE will be giving up approximately $75 million in termination charges that would have been assessed on those 2 million SWUs. Assuming maximum utilization of the free substitution provisions of the modified ISC, 800 thousand SWUs will be furnished by sales from inventories of DOE customers, while DOE production will increase by 1.2 million SWUs, to be sold at $138.65 per SWU. Thus, sales revenues will increase by approximately $166 million. The *net increase* will be approximately $91 million, or $76 per SWU. In essence, DOE is underselling the competition from the secondary market.

In summary:

1. DOE has indicated that it intends to be very aggressive in trying to retain its 3.5-year Requirements contract holders.

2. DOE has altered the conditions of the secondary SWU market again by modifying the terms of the Interim Sales Contract for FY84 and 85.

3. The effects of DOE's latest actions are:

a. To lower the cost of DOE SWUs to $138.65 to holders of 3.5-year Requirements contracts.

b. To provide these 3.5-year Requirements contract holders the opportunity to lower cost further by allowing them to purchase DOE SWUs in the secondary market.

c. To provide an outlet for excess SWUs held by DOE customers (primarily AFC contracts) and to raise the secondary market price of those DOE-origin SWUs.

d. To increase DOE production in exchange for marginal revenues of approximately $76 per SWU, a figure well below variable cost of production.

EXHIBIT 8

SOURCES OF SECONDARY SWU MARKET SUPPLY AND DEMAND

The bulk of **secondary market SWU supply** comes from inventory surpluses and excess commitments associated with DOE Fixed-commitment contracts (both US and non-US customers) and with Eurodif shareholders' obligations to accept deliveries of enrichment services in excess of need. The amount of DOE excesses moving into the market from non-US customers is normally smaller than that available from US customers, but the foreign customers appear more willing to sell at lower prices.

In order to more fully understand the composition of the secondary SWU market supply and demand, some review of DOE contract terms and conditions is necessary. (Exhibit 1 discusses them in more detail.)

The Requirements contract, offered from the inception of the commercial enrichment business until 1972, has two types, differentiated from one another only by their termination provisions. As the customer gives DOE shorter notice periods under Requirements contracts having 3.5-year termination provisions, termination charges increase. Termination charges are zero for notices of 3.5 years or more, while notices of less than one year incur the maximum penalty, 25 percent of the SWU price in effect when the termination notice is received by DOE. Under Requirements contracts having 5-year termination provisions, the customer can partially terminate deliveries at no charge 5 years into the future. For terminations giving less than 5 years' notice, DOE levies a charge of 40 percent of the SWU price in effect at the time notice is received.

The Long-term Fixed-commitment (LTFC) contract, offered in 1973 and 1974, has a ten-year rolling firm commitment period. Unlike the Requirements contracts, wherein the customer need only accept SWUs sufficient to fill actual requirements as defined 180 days in advance of delivery, LTFC contracts caused inventories and commitments to increase to alarming levels. Industry furor over the burden of those inventories led DOE to offer a second generation fixed commitment contract in 1978. This contract, known as the Adjustable, Fixed-commitment (AFC) contract, permitted holders of LTFC contracts to convert to the AFC contract and make a one-time free adjustment to their commitment schedules so as to restore balance between requirements and scheduled deliveries.

The AFC contract contains a five year rolling period of firm commitments (allowing quantity flexibility in the fourth and fifth years). This shorter firm period was clearly an improvement over the LTFC contract, so most of DOE's LTFC customers converted to the new contract. Only 15 LTFC contracts remain in effect, 5 in the USA and 10 elsewhere. By contrast, US customers of DOE hold 104 AFC contracts and non-US customers hold 81. Relief obtained under the terms of conversion to the AFC was short-lived, and excess commitments and inventories once again built up rapidly under the Fixed-commitment contracts.

The foreign enrichers (currently Urenco, Eurodif and Techsnabexport) entered the primary market for enrichment services in the mid-1970s, ending the monopoly that the AEC (now DOE) had enjoyed. Two aspects of foreign SWU supplies should be mentioned here. First, under political pressure, several German utilities terminated the remaining deliveries under their Requirements contracts in order to take supplies from Urenco (with its German participation). These terminations represent a long-term loss of business to DOE of approximately 300,000-400,000 SWUs per year. Second, the Eurodif shareholders are responsible for taking their respective shares of the Eurodif output. In many instances, these SWUs are not needed to support their nuclear power programs. As a result, large inventories of Eurodif-produced SWUs have developed in Europe and the outlook is for those excesses to increase. The fact that so many of those non-DOE SWUs simply are not needed in the foreseeable future is the most important reason for their owners' aggressive sales efforts on the secondary market. The recent strength of the dollar relative to certain European currencies has made sales to US buyers even more attractive. However, secondary market sales of non-DOE SWUs constitute a relatively small portion of the secondary market SWU transactions, especially when compared to the historical level of assignments of DOE SWUs.

When DOE allowed LTFC contract holders to convert to the AFC contract, DOE's business began to erode due to assignments and a contract loophole that became known as "zero free termination". One of the flexibilities in the AFC contract allowed customers to reduce their AFC commitment to DOE to the extent that they substituted for those commitments material previously enriched by DOE. As no fee was associated with this flexibility, a very active assignment market arose in the late 1970s and early 1980s.

Through the assignment mechanism, DOE's customers have assigned away commitments for more than 11 million DOE SWUs for delivery in the period 1983-1990. Non-US customers of DOE have assigned away commitments for over two million SWUs for delivery in the same period. The zero free termination loophole has had a similar effect on DOE SWU supply. By taking advantage of the termination mechanism in the contracts converting from LTFC to AFC, DOE's US customers terminated 8.2 million SWUs and the non-US customers shed another 3.5 million SWUs. In total, DOE has lost more than 25 million SWUs to assignments and zero free termination since the release of the AFC contract. By contrast, 1982 and 1983 secondary market sales have accounted for approximately 5 million SWUs, of which 40-50 percent were of foreign origin. Thus, Assistant Secretary Brewer's contention that the secondary market has "arisen in the past 10-12 months" will not stand the test of scrutiny. It is true, however, that only in the past two years have sales (deenrichment swaps or sales of enriched UF_6), as opposed to assignments, become the predominant portion of the secondary SWU market.

Up until two years ago, most **secondary market SWU demand** came from AFC contract holders and was satisfied by assignment of excess future commitments. Separative work commitments cannot be assigned into Requirements contracts. For the situation in which a DOE customer wishes to assign SWUs from an AFC contract to a DOE Requirements contract holder, DOE developed a contract called the "AFC for Assigned Enrichment Services." A few of these contracts have been issued, but few SWUs have been involved in comparison to the amount of SWUs assigned into AFC contracts.

1. US utilities have accepted assignments of 7.7 million SWUs into their fixed-commitment contracts for delivery in the period 1983 through 1990.
2. For the same delivery period, non-US customers of DOE have accepted assignments of 5.6 million SWUs into their AFC contracts.

During the early 1980s, holders of DOE Requirements contracts became important buyers of secondary market SWUs—both DOE origin and non-DOE origin. A small number of 5-year Requirements contract holders have terminated future deliveries to take secondary market SWUs, but by and large, the 3.5-year Requirements contract holders account for the large majority of secondary market SWU demand in the present market.

EXHIBIT 9

LIKELY RESULTS OF THE USEC

It is difficult to predict how many DOE customers will convert to the new Utility Services enrichment contract (USEC). The success of DOE's efforts to induce customers to accept the Utility Services contract (USEC) will

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depend largely on the contract's terms and the conditions for conversion to it, neither of which is yet final. DOE is reportedly still "market testing" the contract in order to address the negative responses it has received from utility executives allowed to review a preliminary version. In addition, DOE has just released a modified Interim Sales Contract that is being viewed positively by several 3.5-year Requirements contract holders, even though it establishes a tenuous commitment on the part of the customer to accept the USEC if, when released, it is "at least as good as" the contracts they have now. However, Nuexco's assessment of the most likely terms indicates that DOE's success will likely be quite different for different classes of customers.

1. **AFC contracts**—Virtually all US customers holding AFC contracts, perhaps 90-100 percent, will be predisposed to convert to the USEC. Already committed to ten-year contracts having very high termination charges, the AFC holders will value highly the USEC's improved supply flexibility. They will be getting a valuable benefit at a relatively small cost. The requirement to accept DOE as a sole-source supplier will be the only significant drawback. Most non-US AFC customers are also likely to convert, but due to political factors the percentage of customers predisposed to converting is not likely to be as high—perhaps 60-80 percent. For many in this group of customers, the commitment to take all of a reactor's requirements from DOE for the unit's entire lifetime would be so onerous as to eliminate the possibility of their accepting the USEC, regardless of the inducements offered. As a final note, it now appears that those customers having AFC contracts associated with cancelled or deferred nuclear units will not be allowed to convert to the USEC. If so, relief would be denied to the group of customers most in need of it.

2. **3.5-year Requirements contracts**—Holders of 3.5-year Requirements contracts are the least likely to convert. Perhaps 15-25 percent of these contracts will be converted, and those will be utilities that, for political rather than economic reasons, probably would not purchase foreign SWUs anyway. We do not see how any foreseeable form of the USEC can equal the value of the current 3.5-year Requirements contract in meeting the utility goals of supply assurance, flexibility, and reasonable cost.

a. With the right to adjust supply to requirements with only 180 days notice, this group currently has very flexible supply terms.

b. They are currently paying about 8 percent higher prices than they would under the AFC or the new USEC contracts, but they are provided protection from significantly higher prices by an escalated price ceiling clause that will almost certainly be absent from the USEC.

c. Having the right to cancel their DOE supply and buy on the secondary market by paying reasonable termination charges, they have the flexibility to exploit secondary market opportunities. Thus, they already have access to the lowest potential cost enrichment services of any current or anticipated future contract. DOE may offer a short-term advantage for the USEC, but the great majority of utilities probably will decide in favor of the continuing benefits of the 3.5-year Requirements contract.

3. **5-year Requirements contracts**—The holders of 5-year Requirements contracts also will be reluctant to convert. While most of these customers have told Nuexco they will *not* convert to the USEC, the number that will actually do so is still quite uncertain. The 5-year Requirements contract holders least likely to convert are several utilities that have been terminating annual deliveries on a rolling basis five years into the future.

The 5-year Requirements contract holders already have the flexibility to adjust their supply to equal the reactor's requirements on only 180 days' notice, and they would be giving up the right to terminate future deliveries at no cost beyond 5 years if they signed the USEC. The success of DOE's conversion efforts in this category will depend on the near-term incentives offered.

If substantial numbers of Requirements contract holders accept the USEC, it will have two immediate effects on future DOE deliveries.

1. The free substitution in the near term of material previously enriched by DOE will cause a flurry of secondary market activity, thereby reducing DOE deliveries during the transition period.

2. The free substitution provisions also will lead to the creation of a two-tiered secondary market, in which the price of DOE SWUs will be about $20-30 higher than that of non-DOE SWUs. The higher prices will also stimulate more secondary market selling from AFC contract holders' excess inventories. There will continue to be a secondary market for non-DOE SWUs, in which the buyers will be Requirements contracts holders that have not converted.

In the long term, conversion of a substantial number of Requirements contracts would have at least two significant effects on DOE deliveries. (In this context, the long term is the period after which DOE-origin excess inventories have been fed into the new USEC contracts under the free substitution provisions.)

1. Given our current understanding of the contents of the USEC, a utility could not terminate for a fee which

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would make it advantageous to purchase non-DOE origin SWU. Thus DOE demand in the long term would be increased to the extent that DOE succeeds in eliminating its secondary market competition.

2. If the Requirements contract holder wishing to convert has fewer years of deliveries remaining under his Requirements contract than would be covered by the USEC, then DOE would have increased its firm long-term commitments by eliminating the option to switch primary suppliers upon expiration of the Requirements contracts.

MR. WOLCOTT'S RESPONSES TO QUESTIONS DURING THE HEARING

Mr. OTTINGER. Mr. Robert Wolcott, the Chairman of Nuexco, Menlo Park, California.

Mr. Wolcott, we thank you for being with us. We have had an opportunity to read your full statement, and I would appreciate if you might summarize briefly and then answer questions.

Mr. WOLCOTT. I thank you for the invitation. I would like to introduce my associate here, Mr. R. Wesley Miller, our Vice President and Chief Market Analyst.

I think I can keep my comments fairly brief. Mr. Brewer has described the changing environment in the market. I would point out that my particular vantage point relative to this problem is somewhat different, being shaped more by commercial than government experience. Nuexco operates out in the market, and I am certainly not an expert on the inner functioning of DOE. The secondary market developed really out of a need to do something about the excesses which I think everybody recognized.

I would also point out that although the Italians have been quite important in that secondary market recently, they are by no means the only participants in that market, and not all of the SWU which are being exchanged in the secondary market are Eurodif-origin SWU. Some SWU is being sold out of the United States, going from DOE customers into the European market. Some DOE SWU is being sold out of Europe back into the US market, and there have been a number of contract assignments, and so on, in the Far East.

I think that the secondary market has probably come on fairly strong in the last year or so, but probably it is going to be a permanent feature of the market, simply because you never quite get a perfect balance between SWU supply and demand, and somehow this problem has to be taken care of. The secondary market is the mechanism by which that happens.

Our figures indicate that thus far the secondary market has not taken a big share of the DOE market for this fiscal year. It is a little over 10 percent. I think the figures are actually about 12 percent. We anticipate it probably will go on like that for several years. We don't know of any long-term contracts that have been placed by non-US sources (non-DOE) in the United States, but there is the possibility that one or a few could be placed in that way.

DOE has a number of problems. I think these problems make it difficult for DOE to respond to the market very easily or very effectively, because of the constraints placed on them. However, even if DOE could respond I would certainly question from a business standpoint the desirability of doing so. If you are the largest supplier in the world, and you attempt to follow a very volatile secondary market, you almost certainly run the risk of trapping yourself into a position where you will not be able to recover and maintain your position in the primary market.

I am somewhat less optimistic, I think, about DOE's ability to maintain a long-term position in the overseas market. I have been associated with the power business for many years, and the usual pattern is that the US supplies in the early days, for example nuclear power plants, and turbine generators, but eventually nationalism prevails. Local countries take over the supply. Now this has happened, of course, in Europe with Eurodif and Urenco. It has happened in other areas, such as Japan, which produces its own nuclear power plants and its own fabricated fuel. They are working on processes to do their own enrichment, so this market is going to be very difficult to hold, and I am not sure that price alone will be the variable which allows us to stay in that market.

Mr. OTTINGER. Elaborate on that a little bit.

Mr. WOLCOTT. Let me use the Japan Nuclear Fuel Company as an example. I had a part in setting it up, I know its history quite well. I was with General Electric at the time. G.E. started out furnishing all of the fabricated fuel from the United States for Japan. Then Japan and G.E., in combination with two Japanese partners, established a nuclear fuel fabrication plant in Japan. At first the Japanese plant furnished maybe 10 or 15 percent of

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the Japanese need for the reactors, while G.E. furnished the balance. Then the portion of Japanese manufacture grew, and today all of the fabricated fuel is made in Japan.

This same pattern has applied in other things too. It applied to the nuclear power plant itself. It applied previously to turbine generator systems, and the whole line of heavy equipment. If you look at the overseas power market, nearly all of those markets are supplied from national entities.

For example, I think it has been a long time since a US company has sold a turbine generator into England, Germany or France. This transition doesn't happen all at once. It happens over a period of time, and it may not happen for many, many years in Japan, but you always have that threat. You always have that trend to deal with.

Mr. OTTINGER. Regardless of the economics?

Mr. WOLCOTT. Regardless of the economics.

Mr. OTTINGER. Go ahead. Proceed.

Mr. WOLCOTT. I would say that I think that any action which is taken in order to frustrate the function of the secondary market is not really worthwhile. It is very important to get these problems out of the system. This has happened to uranium. Uranium has had a very difficult time and is still having a difficult time. At least uranium is getting into the latter phase now where the secondary market is solving some of the problems. And although the enrichment problem lags behind the uranium problem, I don't see any alternative but to working its way through this convulsion that goes along with getting rid of the excesses. If you try to inhibit that adjustment I think you should prepare for a bigger convulsion later on.

Based on my own business beliefs, too, I do not think it is good for the United States to worry too much about trying to be the lowest priced supplier in the world. I think the US, being the largest volume supplier, really ought to be the price leader, and the others will follow it up.

But as a matter of business generally, if you are the largest volume supplier and you try to reduce prices to match the fellow who is trying to build or maintain his market position, you generally erode the whole primary market. I think that should be a major concern for the United States.

I can take whatever questions you like from here.

Mr. OTTINGER. Do you think on a straight business basis it would be wise for the United States to get out of its uneconomic production and buy its needs on the world market?

Mr. WOLCOTT. This is what happened in the uranium business. The price of uranium got low enough so it was more economical for producers to buy on the local markets and supply their contracts because they could buy more cheaply than they could produce. This does have an advantage in that it is one way to soak up excesses for the market fairly rapidly and get back to a more stable condition.

This was very helpful in the uranium market. At one time, two-thirds of the buyers for uranium were producers rather than users. Certainly that is an alternative worth looking at, because the secondary market price is probably down below or close to just the electrical power costs today for the diffusion plants.

Mr. OTTINGER. Ms. Hull?

Ms. HULL. Mr. Wolcott, have you had the opportunity to review the sales contract and proposed modified version?

Mr. WOLCOTT. I have not personally.

Mr. MILLER. We have seen the Interim Sales contract that was issued in July, but we have not yet seen the modified version issued week before last.

Ms. HULL. At this point is your information sufficient so you can speculate as to the effect these offers might have on the customers?

Mr. WOLCOTT. Yes, we have a lot of information relative to them. I just haven't read the particular draft.

Ms. HULL. Would you like to give us your impression of the effect these offers will have on DOE's customers and on the market in general?

Mr. WOLCOTT. Well, the first one, the Interim Sales contract, that dropped the price for the 3.5-year Requirements contract about $11. That, in turn, stimulated the secondary market to drop its price about $11 in order to maintain the same level of incentives. A few utilities did accept that Interim Sales contract. There are quite a number that have not. Then there was a second version, what we call the modified Interim Sales contract and this in essence allowed for much freer exchange of DOE SWUs among customers. That could have a number of effects.

I think we will have to wait and see exactly what shakes out of that. Certainly one effect was to increase the price for DOE secondary SWUs, because money which previously flowed to DOE under termination charges now in essence flows to the seller of DOE SWUs. So I think it raised the level of activity and the price.

It may also have an effect on the foreign markets. For example, Enusa handles all the fuel business for Spain. They have a Russian contract. I think they also have Eurodif and Urenco contracts. They also have DOE contracts. Of course they have excess SWU now.

Obviously they will sell the SWU that is most valuable on the secondary market. That would be DOE SWU, so it may tend to funnel DOE SWU back into the US market. Enusa could then use the SWU which is produced elsewhere, because all SWUs are the same as far as use is concerned. However, they are not all the same as far as market value is concerned.

Ms. HULL. Do you have any conclusions or comments on the actions that have resulted from DOE's proposed contracts?

Mr. WOLCOTT. I have some thoughts related to modification to DOE's Interim Sales contract. Mr. Miller made some calculations that would indicate to us that its net effect is for DOE to sell more SWU at a net revenue gain of around $76 per SWU. Perhaps you could expand on that.

Mr. MILLER. Exhibit 7 of Mr. Wolcott's remarks goes into detail. For purposes of analysis, we could assume that by offering the modified Interim Sales contract, DOE might have forestalled the termination of some quantity of Requirements contracts SWUs, say two million. In the end the quantity doesn't matter to the conclusion. If we assume that those customers that accept the DOE offer of the modified Interim Sales contract take maximum advantage of its free substitution provisions, and thereby acquire 40 percent of their two million on the secondary market from sellers of DOE SWUs, then DOE gains the sale of 1.2 million SWUs. At $138.65 per SWU, that would produce revenues on the order of $166 million.

However, in order to induce the additional sales, DOE would have foregone the termination charges on the total quantity of forestalled SWUs. In this example, the quantity of two million SWUs equates to roughly $75 million. So the net increase in cash flow would be on the order of $91 million, or $76 per SWU in marginal revenue per each additional SWU sold by DOE.

So for every SWU by which DOE increases its sales as a result of customers accepting the modified Interim Sales contract, marginal revenues amount to around $76. And that we believe is well below the variable cost.

Ms. HULL. For a moment can we just pretend a role play? Would you imagine for a moment that you are a fuel manager for a domestic US utility. What would you do now on behalf of your company if your company held a 3.5-year Requirements contract with DOE?

Mr. WOLCOTT. I would keep it. It would take quite an inducement for anyone to give up a 3.5-year Requirements contract because you have a great deal of flexibility. And if associated with that inducement in any way was a provision which would lock you into sole source supply for 20 or 30 or 40 years, whatever it may be, I think you would be extremely reluctant to accept that. And that is the attitude of the utilities, too.

Ms. HULL. Would that apply as well to holders of 5-year Requirements contracts?

Mr. WOLCOTT. The indications we have are that you probably have some 5-year contract holders who might change, and some who will not. The utilities themselves, you know, are not a monolithic group. Some insist on domestic supply and I think you can count on a certain amount of DOE SWU, no matter what.

Those insisting on DOE SWU are the easiest to change because they don't anticipate doing anything else anyway. So they take the concessions. Then there are others that are willing to buy either overseas or domestically, and they put a much higher premium on the flexibility.

I don't know how this proportion might break down, but we do know there are some on both sides.

Ms. HULL. Do you have any feel for the proportions that might go one way or another?

Mr. MILLER. We have done some studies on the subject, but not in a rigorous quantitative fashion. We have sampled opinions among our brokers who we believe are very close to utilities, and we have a clear consensus that very few 3-5 year Requirements contract holders would convert to what we expect to see in the Utility Services contract (USEC). They would perceive little incentive.

On the other hand, the most likely response of 5-year contract holders is not so clear. The degree to which the USEC grants them access to easy substitution of DOE SWUs in the short term would be an important factor in their decision to convert or not convert to the USEC. AFC contract holders would be more likely to convert to the USEC than would Requirements contract holders, but even they would be deterred—and Nuexco believes substantially so—by the provisions binding them to sole-source supply (DOE) for the remainder of their reactors' lifetimes.

Ms. HULL. So is it fair to say that your conclusion is that DOE's goal of having most of its customers on one type of contract is somewhat illusory?

Mr. WOLCOTT. Yes. I really don't think there is any possibility at all of that happening because, to set all customers under one type contract, DOE would have to offer something good enough to attract the most reluctant 3.5-year Requirements contract holders. This would be very costly because you have to take in all the others. You would be really pricing to the most difficult customer and giving everybody else the advantages.

I think what you end up with is one more combination of contracts.

Ms. HULL. Thank you.

Mr. OTTINGER. We thank you very much for your help, Mr. Wolcott. Appreciate your being with us.

Mr. WOLCOTT. Thank you.

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PART TWO: OTHER TESTIMONIES

OPENING STATEMENT OF THE HONORABLE RICHARD L. OTTINGER

Chairman of the House Subcommittee on
Energy Conservation and Power

Today the Subcommittee will receive testimony on the state of the uranium enrichment program of the Department of Energy, its goals, and its strategy to achieve those goals.

Although the enrichment program alone represents over 20 percent of DOE's budget, it has been able to keep a relatively low profile by its ability to offset federal appropriations with revenues received for its services. This equilibrium may be upset in the FY 1985 budget due to decreasing revenues concurrent with a burgeoning construction program.

DOE has suffered losses of direct sales customers to foreign enrichment services suppliers and to the glutted secondary market. In an attempt to prevent further losses, DOE has offered price and other inducements to its customers. These inducements, if accepted, will further reduce DOE's revenues, although perhaps lessen the loss of sales. We look forward to DOE's analysis of the impact these losses have had and will have on its budget.

I have made no secret of my belief that DOE's current construction program is too much too soon. This Committee is interested in working with the Department to stabilize a rational, coherent and efficient program for providing needed uranium enrichment services. It is crucial that the Department establish its program direction, marketing goals, and an achievable strategy which can generate wide consensus prior to the submission of the FY 1985 budget.

The Department has been working throughout the summer to completely reassess the enrichment program. I am disappointed that the Department has not been able to complete its reappraisal in time for this hearing, as was originally intended. I hope that the Assistant Secretary will provide the Subcommittee with some insight on the progress of this appraisal.

I have requested that today's witnesses review the enrichment market situation and provide the Subcommittee with their assessments of current and future demand for United States enrichment services and the effect of DOE's recent actions on short- and long-term enrichment demand. The Subcommittee is interested in the extent of the threat to DOE's revenues posed by the active secondary market and the possible effect the draft Utility Services contract will have on DOE's market.

A marketing goal is necessary to determine the need for, size, and timing of DOE's planned construction program.

The recent reports of the General Accounting Office and the Congressional Budget Office graphically demonstrate the promise and potential of the advanced enrichment technologies. I am committed to assuring that these technologies are pursued as aggressively as possible. The estimated dates of commercial deployment have advanced rapidly. In view of this, I would not be favorably inclined to an enrichment budget request which did not include sufficient funds to enable prompt commercialization of the most cost-effective technologies.

TESTIMONY OF SHELBY T. BREWER

Assistant Secretary for Nuclear Energy
Department of Energy

Introduction

The world market for enriched uranium and the US share of that market have changed dramatically over the past 10 years. In the past 12 months the character of the US domestic market also has begun to show evidence of change. As matters now stand, the US is not competitive with other producers, nor are we competitive with excess world inventories. To reclaim our leadership in international nuclear commerce, we must find a sound, businesslike route through this market crisis, so that we will emerge at the other end with superior enrichment technology, production capability, and economics. The key to achieving this transition is a clear understanding of the market, based on realism rather than wishful thinking, and a commitment to make decisions based on sound business principles.

For the past nine months, as the erosion of our US domestic market became evident, the Department has been conducting an intensive review of its enrichment enterprise, with an eye toward adjusting its business posture (pricing, contracting, etc.), as well as its long-term strategic plan for production and technology deployment. I would like to describe in some detail the evolution of the uranium enrichment market and prospects for the future.

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Evolution of the US Uranium Enrichment Enterprise (1964-1973)

In the early 1960s, enriched uranium was government-owned and leased to utilities. In 1964, the Private Ownership Act authorized the ownership of nuclear fuel by licensed utilities, and from 1969 to 1972, DOE contracted with utilities under a Requirements contract, which was very flexible to the utilities and very inflexible to the government. In 1973 and 1974, the government established the Long-term Fixed Commitment contract, with a firm 10-year utility commitment requiring firm quantities and delivery dates.

Evolution of Competition

The United States monopolized the world enrichment market until the mid-1970s. When the United States closed its order books in 1974, we indirectly gave a large boost to the European suppliers who were already in the process of constructing capacity for their own national supplies. The Eurodif plant achieved initial operation in late 1976. Current Urenco capacity is 1 million SWUs per year, with plans to expand further as additional enrichment contracts are signed. Finally, Techsnabexport (USSR) sells excess enrichment services, primarily as a means of obtaining hard currency. They have about 3 million SWUs per year excess capacity available for sale, but are not expected to be a major force in the future.

Both Eurodif and Urenco have developed aggressive marketing programs to expand their contracting base and thus reduce the drain of idle excess capacity on their financial position. Eurodif's marketing is now performed by Cogema, which recently made two sales to domestic utility customers, and appears to be targeting major DOE markets for additional sales opportunities. Eurodif and Urenco are both able to offer more flexible contractual arrangements than is DOE, as each Eurodif contract can be individually negotiated. At present, Eurodif enjoys a price advantage over DOE, primarily because of the devaluation of the French franc.

Loss of Foreign Market

Until 1973, the US enjoyed 100 percent of the foreign enrichment market. The order books were closed in 1974 and remained closed until 1978. By then, Eurodif and Urenco had siphoned off about 30 percent of the non-US market. By 1980, our share had decreased to about 35 percent. Between 1980 and 1982 we have regained some ground—to about 38 percent of the foreign market. In the late 1970s, the US image as a reliable supplier was further undermined through the evolution of a more restrictive nuclear export policy. The Nonproliferation Act of 1978 projected the US as arrogant and condescending. Before 1981, the US held a significant price advantage over Eurodif and Urenco. Escalation of power costs, as well as the strength of the US dollar have now placed the US at a price disadvantage with foreign suppliers.

Erosion of the US Domestic Market and Emergence of the Secondary Market

In the past 10 months the domestic uranium enrichment market has been threatened for the first time, both by sales of foreign-origin material to US utilities on the secondary market and by loss of primary sales to foreign producers. As with the foreign market, this domestic erosion can be traced to unfavorable price and contract terms.

The central problem facing the US enrichment enterprise is a massive imbalance between world production and consumption. Utilities are willing to resell their excess enriched uranium at prices below current costs, through secondary market transactions. The US is beginning to absorb the excess. Several utilities have terminated DOE contracts, in the past year in favor of European producers. In general, they were lured in that direction by the uncertainty in US price growth, by the strength of the US dollar, by tailored contracts as opposed to the rigidity of US enrichment contracting practices, and by the lack of clarity in our long-term enrichment policy.

Uranium Enrichment Market Projections

Our recent analyses of the SWU demand to be supplied by DOE have been predicated on the basis of a 1983 projection of US nuclear power growth to 110-150 gigawatts of nuclear electric generating capacity in the year 2000. Our pessimistic estimate of DOE's share of the world market is less than 45 percent of the EIA mid-case projection of 350 gigawatts of free world LWR capacity in the year 2000.

Our projection of worldwide supply represents expected deliveries to free world utilities currently committed under contracts to one of the world's primary enrichment suppliers. During the next few years, deliveries will continue to exceed demand; these excess deliveries will be added to the already large inventories held by utilities. Whereas DOE has contributed to this buildup through its Fixed-commitment contracts, the majority of the inventory was produced by other suppliers. Currently, France, Italy, and Spain hold the largest portions of this inventory, and Italy and Spain have the greatest incentive to dispose of their inventories, as their nuclear

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programs have experienced massive delays. The owners of these inventories are actively seeking to sell material on the secondary market by offering prices below those of primary suppliers.

DOE's Requirements contracts holders are the primary candidates for the disposal of secondary market material, because of the lenient termination provisions in these contracts and the small number of Requirements contracts held by foreign suppliers. DOE has 75 Requirements contracts with domestic and foreign customers. Under 45 of the contracts, the customer can terminate without penalty with a 3.5-year notice. The remaining 30 contracts permit free termination with 5 years notice. Because of the large discounts available on the secondary market, requirements customers with 3.5-year termination provisions can terminate deliveries from DOE, pay the termination penalties, and still save money by purchasing SWUs on the secondary market. The terminations received in advance are growing yearly, reflecting the customers' desire to avoid termination charges and buy on the secondary market. While no expected terminations are shown for customers with 5 year provisions, some could develop as sellers on the secondary market begin to offer SWUs at prices low enough to offset the 40 percent termination charge. Reversal of these trends is essential for DOE to retain financial viability.

Conclusions

The US has not operated the enrichment enterprise as a business; over the years we have misread or disregarded the market; we have handcuffed ourselves with contracting and marketing constraints; we have acted as though we are monopolists when we are not; we have antagonized all of our customers, both foreign and domestic. We are not competing but reacting.

The potentially very serious loss of market, and the attendant revenue loss, come at a time when we are engaged in major investments in advanced technology to regain market leadership, and at a time when we are trying to minimize net positive appropriations. I would suggest that we break the problem into two parts: how we deal with urgent but transient near-term market problems, and how we emerge in a technologically and economically commanding position when this transient has passed and supply and demand forces once again determine new production.

The market, revenue, and financing problems that we face will be very difficult to solve. However, the comprehensive strategy currently being developed, which will be presented in concert with the FY 1985 budget, will contain measures to address the difficult short-term problems with a program that is financially and technically sound.

STATEMENT OF DR. ROBERT CIVIAK

Specialist in Energy Technology
Science Policy Research Division
Congressional Research Service

World Enrichment Supply

There are four primary enrichment suppliers. The United States Department of Energy, the Soviet Union, Eurodif and Urenco. Together they are currently capable of producing about 42 million SWUs per year, more than twice the needs of all the world's nuclear powerplants. If those suppliers complete enrichment plants now under construction as scheduled, and do not retire any existing plants, their capacity will increase to over 55 million SWUs per year by 1995. Enrichment plants under construction or planned in Japan, Australia, Brazil, and South Africa may add another 3 million SWU per year by 1995.

In addition to the primary suppliers, a secondary market in enrichment has developed, which could represent a major source of supply over the next few years. The origin of the secondary market is private stockpiles of enriched uranium which have accumulated because customers were bound by long-term contracts to purchase enrichment in excess of their needs. There are currently about 30 million excess SWUs held by enrichment customers, about one and a half times the amount of enrichment produced by the primary suppliers last year, so private stockpiles represent a substantial supply of enrichment.

Table 10 summarizes the existing enrichment plant capacity and the planned capacity of primary Western suppliers in 1990 and 1995. Actual production might be significantly lower. For example, while the US capacity has been 27 million SWU per year for the past two years, actual US production has been at or below 12 million SWUs per year.

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Table 10

WORLDWIDE URANIUM ENRICHMENT CAPACITY: EXISTING AND PLANNED
(millions of SWUs per year)

		Existing Capacity	Planned Capacity	
Supplier	**Process**	**1983**	**1990**	**1995**
United States				
Oak Ridge, Tenn.	diffusion	7.9	7.9	7.9
Paducah, Kent.	diffusion	11.4	11.4	11.4
Portsmouth, Ohio	diffusion	8.0	8.0	8.0
Portsmouth, Ohio	centrifuge	—	2.2	13.2
Subtotal US	diff. + cent.	27.3	29.5	40.5
Eurodif	diffusion	10.8	10.8	10.8
Urenco	centrifuge	1	2	2+
Soviet Union (for export)	diffusion	3	2-3	2-3
Japan	centrifuge	0.05	0.2	1-2
South Africa	helicon	0.03	0.3	0.3
Brazil	jet-nozzle	—	0.1	0.3
Australia	centrifuge	—	—	1
TOTAL		42	45-46	58+

In fiscal year 1983, the **US DOE** diffusion plants produced about 12 million SWUs, and DOE sold about 14.2 million SWUs. The difference was made up by drawing down a stockpile of enrichment that had been accumulated in earlier years. About 12 million SWUs in excess of what is needed for a working inventory remains in the DOE stockpile.

In addition to the existing diffusion plants, DOE is building a new plant near Portsmouth, Ohio, which is designed to use a gas centrifuge process. The Gas Centrifuge Enrichment Plant (GCEP) is scheduled to begin partial operation in 1988 and reach its current design capacity of 13.2 million SWUs per year in 1994.

DOE is also developing advanced centrifuges capable of being installed in the GCEP plant, with the goal of doubling the capacity of that plant. In addition, DOE is developing a laser isotope separation technique which its proponents believe may provide the lowest cost enrichment in the 1990s.

Eurodif owns and operates a single enrichment plant at Tricastin, France. The plant, which uses the diffusion process, began operation in 1978. The Tricastin plant has the capacity to produce 10.8 million SWUs per year. However, only 5.5 million SWUs were produced and sold between October 1982 and October 1983.

Urenco centrifuge enrichment plants with capacities of about 0.4-0.6 million SWUs per year are operating at Almelo in the Netherlands and at Capenhurst in England. Urenco plans eventually to increase the capacity of each of those plants to one million SWUs per year, and is building an additional one million SWUs per year centrifuge enrichment plant at Gronau in West Germany. Between October 1982 and October 1983, Urenco produced about 0.6-0.8 million SWUs.

The **Soviet Union,** through its marketing agent Techsnabexport, currently holds contracts for the export of between two and three million SWU per year. Most of its exports are under long-term contracts executed during the 1970s with countries which now have interests in Eurodif or Urenco. Customers in those countries could stop purchasing enrichment from the Soviets in favor of their domestic suppliers when their contracts expire in the early 1990s. The Soviets price their enrichment at five percent below the US price.

There are currently 30 million **excess SWUs** held by enrichment customers in the USA and abroad. About one-half of those SWUs were originally produced and sold by DOE and the rest are of foreign origin. The size of the secondary market for the next few years will depend upon the price and contracting terms that the primary enrichment suppliers offer and the pressure on utilities to sell off their excess SWUs. About 5.4 million SWUs were traded on the secondary market in FY83.

Demand

World enrichment demand is estimated to increase from a current level of about 16 million SWU per year to 36 million SWUs per year in 1995, as shown in Table 11.

Table 11

PROJECTED ENRICHMENT DEMAND[1]
(millions of SWUs)

Year	Enrichment Demand
1983	16.3
1985	22.0
1990	30.1
1995	35.7

[1] Uses conversion factor of 0.112 million SWUs per gigawatt of installed stalled capacity using enriched uranium. (That conversion factor is an average value from DOE's Dec. 1982 yearly nuclear powerplant capacity and enrichment demand projections for the United States from 1984-2000. The yearly conversion factors vary from 0.095 to 0.122 because of the different SWU requirements of new reactors and those in equilibrium.)

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FY83 SWU sales by primary enrichment producers alone were about 23.4 million SWUs—14.2 million by DOE, 5.5 million by Eurodif, 3 million by the Soviet Union, and about 0.7 million by Urenco. Hence, enrichment supply exceeded the demand by over seven million SWUs in 1983—and that in a year in which DOE and Eurodif operated their enrichment plants at little more than half of their full capacity. In conclusion:

1. The existing production capacity of the Department of Energy, Eurodif, and Urenco alone is sufficient to meet projected world demand in 1995.

2. If all the enrichment capacity planned for 1995 is completed, it would exceed the projected world demand in that year by more than 60 percent.

US Market Share

The demand for enrichment supplied by the USA will depend upon US marketing efforts, as well as other factors. Instead of estimating what the US market share will be, I have calculated the maximum and minimum demand levels that the United States might satisfy through 1995 based on externally imposed market limits.

For the maximum level, I have assumed that the US would supply the entire projected enrichment needs of all countries except those that have shares in Eurodif or Urenco and four countries which are currently excluded from US sales for non-proliferation reasons. At the other extreme, for the minimum level, I have assumed that the United States supplies only the demand remaining after all other suppliers sell all of the enrichment they can produce.

What I found was that the difference between the minimum and maximum US enrichment markets is quite small in 1990 and 1995 when one considers the extremely different assumptions by which they were estimated—In 1995, I estimate the minimum US enrichment market to be 18.3 million SWUs and the maximum to be 23.7 million SWUs. It is instructive to compare such estimates with the latest available Department of Energy projections of enrichments services to be supplied by DOE through 1995.

The Department of Energy's December 1982 country-by-country estimate of the nuclear power capacity most likely to be supplied with enrichment services by the United States in 1985, 1990, and 1995 is shown in Table 12. That estimate was predominantly based upon current enrichment supply contracts held by DOE and anticipated extensions of those contracts. DOE also included a small number of new contracts and contract cancellations.

Table 12

"MOST LIKELY" NUCLEAR POWERPLANT CAPACITY TO BE SUPPLIED WITH ENRICHMENT SERVICES BY US DOE
(Gwe in operation at end of year)

Country	1985	1990	1995
France	1.9	0.0	0.0
Fed. Rep. of Germany	5.0	4.6	3.9
Japan	17.2	23.4	39.9
Korea	2.1	4.8	4.3
Mexico	0.0	1.3	1.9
Netherlands	0.4	0.4	0.4
Philippines	0.0	0.6	0.6
Spain	6.0	6.9	6.9
Sweden	7.4	8.4	8.4
Switzerland	2.5	1.6	1.6
Taiwan	4.0	4.9	4.9
Yugoslavia	0.6	0.6	1.6
TOTAL NON-US	47.1	57.5	74.3
United States	86.2	117.7	122.4
TOTAL CAPACITY	133.3	175.2	196.7
TOTAL SWUs (millions)	14.8	19.3	22.3

The DOE estimate means the Department expects to supply enrichment services to 100 percent of the US nuclear power capacity in operation through 1995, 43 percent of foreign capacity in operation in 1985, and 37 percent of foreign capacity in operation in 1990 and 1995.

The maximum enrichment market available to the United States may be estimated by assuming that all Western customers other than members of Eurodif and Urenco buy all of their enrichment from the United States. Under that assumption, we estimate that the maximum market for United States enrichment services is an additional 10.1 GWe in 1985, 18.7 GWe in 1990, and 23.8 GWe in 1995 above the DOE estimate. This maximum available market is only about a ten percent increase over DOE's most likely estimate in each of those years. Given the vigorous competition from foreign enrichment suppliers and the secondary market, the DOE December 1982 estimate may be too optimistic.

One may conclude from this that the US share of the world enrichment market in the early 1990s is relatively insensitive to whether the Department of Energy attempts to maximize its sales or is content to meet only the demand that its competitors cannot satisfy. That

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finding differs from what is found for both the short-term and longer-term. In the short term, the large excess enrichment supply and private stockpiles threaten a substantial portion of the current DOE market. United States enrichment sales may vary greatly depending upon DOE pricing and marketing practices.

Government Goals for a US Enrichment Enterprise

After discussions with a range of people interested in enrichment, I was able to identify four broad goals which appear to be widely accepted.

1. Assure an adequate long-term supply of enriched uranium for domestic utilities and defense purposes.
2. Minimize the cost to consumers of enrichment services.
3. Support nuclear weapons non-proliferation objectives.
4. Avoid any net federal spending on enrichment.

In the long term, these goals may all be satisfied by a market strategy aimed near the middle of the projected maximum and minimum demand levels for US enrichment. This may be a better strategy than attempting to maximize the US market share, because such a strategy increases the chances of matching supply and demand, which, given the capital intensive nature of the enrichment enterprise, is important for holding down enrichment costs.

In the short term, it may be difficult to satisfy all four goals with any market strategy. The cost of enrichment to consumers could be reduced in the short-term if DOE were to release customers from contractual obligations and allow them to purchase lower-priced enrichment on the secondary market or from foreign suppliers. However, that would result in smaller revenues for DOE, which under current funding arrangements for DOE's enrichment activities could make it difficult to finance modernization of enrichment production capacity without sizable net government appropriations.

On the other hand, if DOE retains a large share of the short-term enrichment market, the revenues might be sufficient to finance development and construction of new capacity. This approach could require either holding customers to contracts that do not allow them to minimize costs (sacrificing goal 2) or reducing DOE prices and possibly not recovering the full government cost of enrichment (sacrificing goal 4).

It would appear that if the goals of minimizing the cost of enrichment to consumers and avoiding net federal spending on enrichment are both to be maintained, it may be necessary to slow the pace of development and construction of new enrichment capacity considerably or find an alternate means of financing those activities.

Thank you for your interest and attention. I hope my remarks will be of assistance to the committee. I will try to answer any questions you may have. However, I must remind you that as a CRS witness I must refrain from advocating positions on policy decisions facing the Congress.

TESTIMONY OF THOMAS B. COCHRAN AND JEFFREY I. SANDS

Natural Resources Defense Council

This testimony addresses two questions: first, the nuclear weapons proliferation risks associated with development of Advanced Isotope Separation (AIS) processes, and, second, the advisability of proceeding with Phase II of the Set III GCEP machine procurement contracts to be let this fiscal year.

Nuclear Weapons Proliferation Implications

We endorse the finding regarding proliferation considerations of AIS technologies of the ERAB Study Group's 1980 Report on Advanced Isotope Separation, and the report's conclusion that proliferation risks should be treated as a central design problem for the processes.

The greatest proliferation risk associated with federal AIS development is DOE's plan to employ Pu-LIS to enrich 10-15 tons of fuel-grade plutonium in the existing DOE stockpile, including plutonium derived from or currently used in civil R&D reactors, for its use in the weapons program. This DOE plan is not prohibited by law due to a loophole in the Hart-Simpson-Mitchell Amendment to the Atomic Energy Act (Section 57, PE). It violates, however, the spirit of the NPT presumption against the use of civilian nuclear technology for military purposes and undermines the bed-rock foundation of US non-proliferation policies that a clear distinction can be justified on the basis of either economics or national security, and we urge the committee to support efforts to close this loophole. DOE has also failed to prepare a programmatic Environmental Impact Statement (EIS) for Pu-LIS as required by NEPA, and we urge this committee to demand that DOE comply with the NEPA requirement.

DOE's work on the Plasma Separation Process (PSP), also being funded under DOE's Defense Programs budget, has significant nuclear weapons proliferation implications. PSP could significantly increase the proliferation hazard of worldwide uranium enrichment activities due to its modular design, established technology and hardware, and smaller size. The technology has not been demonstrated. Due to PSP's proliferation potential, it is questionable whether this program should be continued.

Phase II Set III Machine Procurement

The US has a huge excess in uranium enrichment capacity with the three existing gaseous diffusion plants, and the current market situation does not compel us to add new Set III capacity in order to meet demand until the early 1990s when AGC and AVLIS technologies will be fully developed. Since a decision between construction of AGC or AVLIS capacity cannot be made at this time, a decision to build process buildings beyond the first two at GCEP, already committed, should be deferred until the 1986-1987 AGC vs. AVLIS competition is complete.

We see no economic advantage in Phase II Set III machine procurement and deployment over continued operation of GDP capacity. In fact, there very well could be a significant economic *penalty* associated with continuing Phase II Set III procurement activities. We therefore urge this committee to ask DOE to cancel or minimize the procurement of Set III machines via Phase II contracts to the lowest possible level consistent with retaining a capability to deploy AGC (Set V) in a timely manner.

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NUEXCO

DECEMBER 1983 NUMBER 184

Monthly Report on the Nuclear Fuel Market

NUEXCO

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EXECUTIVE SUMMARY
REPORT 184
(All data as of November 30, 1983)

Exchange Value $22.50, down $1.00	The **Exchange Value** is **$22.50** per pound U_3O_8, down $1.00 since last month, the second month of decline in a row. Five uranium sales transactions are reported, involving approximately 6.2 million pounds U_3O_8. All **transactions** involved concentrates, and two were long-term sales of large quantities.
Supply-Demand Ratio down slightly to 1.8:1	Active spot and near-term **uranium supply** amounts to **5.7 million** pounds U_3O_8 *equivalent*, down 0.2 million pounds from last month. Active spot and near-term **uranium demand** totals **3.1 million** pounds. The spot and near-term **supply-demand ratio** dropped slightly to **1.8:1**.
Transaction Value rose to $23.85	The **Transaction Value is $23.85** per pound U_3O_8. It includes 16 transactions involving a total of 2.3 million pounds U_3O_8 equivalent and covers a period of 5 months.
Loan Use Charge Rate unchanged at 6%	The **Loan Use Charge Rate** remains **6 percent** per annum. No loans are reported.
Conversion Value remained at $0.60	The **Conversion Value** is **$0.60** per pound U as UF_6, unchanged since last month. No transactions are reported. Active secondary market supply of conversion services for delivery within three years totals 5.2 million pounds U as UF_6; active demand amounts to 1.3 million pounds.
SWU Values $110 for DOE-origin (FY 84) $90 for non-DOE origin (delivery within 15 months)	The **SWU Values** are **$110** per SWU of DOE origin and **$90** per SWU of non-DOE origin. Eight SWU transactions are reported this month, involving a total of 3.2 million SWUs. Four of those transactions involved large amounts of non-DOE SWUs for long-term delivery. Spot and near-term supply of secondary market enrichment services amounts to 900 thousand SWUs; spot and near-term demand totals 600 thousand SWUs.
Enrichment	A slight clarification of DOE's modified ISC is likely to increase the number of 3.5-year Requirements contract holders that convert to the contract.
Argentina	Argentina is operating a gaseous diffusion enrichment plant, and a reprocessing plant is under construction.
Australia	The Australian government approved a plant that permits development of the Olympic Dam project but does not allow any other uranium projects to proceed.
China	The People's Republic of China entered into an agreement with Hongkong for construction of twin PWRs in the southern province of Guangdong.
Namibia	Nuexco's forecast of production from Namibia has been revised upwards to reflect the extension of an existing contract agreement.
Turkey	The government is considering four vendors for its planned Akkuyu unit, but construction is unlikely to begin for some time.
Basic Considerations	The first in a series of articles reviewing the basics of the nuclear fuel cycle covers separative work units (SWUs).
Forecast	Nuexco's most recent forecast of SWU consumption predicts growth from approximately 16 million SWUs in 1983 to 27 million SWUs in 1990.
Focus: West Germany	West Germany's nuclear program suffered a severe setback in the mid-1970s, but is recovering now thanks to a centrist government and an innovative construction concept, the convoy system.
Raw Materials	The uranium resource at Olympic Dam in South Australia is more than twice the size of any other known uranium resource in the world, and uranium is only a secondary mineral of the gigantic deposit.
Government Statistics	Monthly figures from January 1979 through December 1982 are listed for Australia, Canada, South Africa and the United States.

This Executive Summary may be reproduced for internal distribution.

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NUEXCO REPORT 184 FIGURES OF THE MONTH (November 30, 1983)	This Month (Report 184)	Last Month (Report 183)	12 Months Ago (Report 172)
Exchange Value[1]	22.50	23.50	19.75
Transaction Value[1]	23.85	23.65	17.55
Conversion Value[2]	0.60	0.60	1.45
Loan Use Charge Rate[3]	6%	6%	6%
Near-Term Uranium Supply[4]	5.7	5.9	5.2
Near-Term Uranium Demand[5]	3.1	3.1	5.2
Near-Term Supply-Demand Ratio	1.8	1.9	1.0
Recent Uranium Sales:			
Number of Transactions[6]	5	3	9
Quantity of Material[7]	5.4-9.0	0.1-0.3	6.1-12.1
Nuexco SWU Values:[8]			
DOE origin, FY 84 delivery	110	115	
non-DOE origin, delivery within 15 months	90	85	
USDOE SWU Prices:			
AFC	138.65	138.65	138.65
Requirements	149.85	149.85	149.85
Market Value of Enriched UF_6[9][10]:			
2.5 w/o U_{235}	625.72	653.63	693.19
3.0 w/o U_{235}	803.08	838.93	895.97
3.5 w/o U_{235}	983.72	1,027.67	1,102.91
4.0 w/o U_{235}	1,166.80	1,218.95	1,312.91

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THE URANIUM MARKET:
GRADE—NOT ALWAYS A CRUSHING EXPERIENCE

By

George White, Jr.
President
Nuexco

Presented To:

Northwest Mining Association

Spokane, Washington
December 1, 1983

THE URANIUM MARKET: GRADE—NOT ALWAYS A CRUSHING EXPERIENCE

By

George White, Jr.
President, Nuexco

Introduction

The topic of this session, "Foreign Influences on Domestic Mining," and my particular part, uranium, is an interesting and timely pairing. US production was over 43 million pounds U_3O_8 in 1980, declined to 38 million pounds in 1981, plummeted to 26 million pounds in 1982 and will drop to about 20 million pounds in 1983. And during this same period, foreign uranium producers marketed aggressively and successfully in the United States. One is liable to think, "Clearly the foreign sellers are the villains responsible for the uranium price collapse, the devastation of the US uranium industry, the US dependency on imported uranium." But this is not the case. On the contrary, and inconveniently, the big villain is much closer to home. He is none other than your friendly government, who, as usual, was only trying to help.

Historical Perspective

In the late 1960s and early 1970s, the domestic US uranium industry was in the doldrums. There was a big demand gap. Government procurement programs had ended and purchasing for the emerging nuclear power program had not yet taken up the slack. Too many uranium miners were chasing too few buyers; the competition for every order was fierce; prices were soft.

Late in 1972 and on through 1973, a number of events occurred which, when combined, were destined to send uranium prices to unheard-of heights. In no particular order of importance, four key events stand out.

1. The Arab oil embargo. This non-nuclear event spawned two subsidiary nuclear events. First, a rash of new nuclear plant orders. In the 1972-1974 period a total of 107 nuclear plants were ordered by US utilities, creating new uranium demand for nearly 150 million pounds U_3O_8 through 1983. (In those good old days we thought we could build nuclear plants in 5 or 6 years). The second subsidiary event was the legitimation of high energy prices. Oil prices rose, coal prices rose, why not uranium prices?

2. Another subtle but significant event was the now-famous short sales by Westinghouse. By taking 120 million pounds of uranium demand out of the market without effecting covering purchases, Westinghouse held back normal price development.

3. The US government, in its wisdom, reaffirmed its embargo on the use by domestic utilities of non-US origin uranium. Importation could only begin in 1977 with increasing amounts in later years.

4. Probably most importantly, the US government altered its enrichment policies. While you don't want to be overwhelmed with the technical aspects of enrichment, it is important to understand the extremely close linkage between enrichment policy and uranium demand. The key feature of the revised enrichment policy was the requirement for long-term contractual commitment (as much as 18 years in advance). Previously utilities had to give only 6 months prior notice of how much enrichment they wished to buy. The utilities, convinced that nuclear growth was going to be dramatic, and mindful of the warnings that a shortage of enrichment capacity was likely, rushed to sign these new contracts to insure enrichment supply. The key action that utilities had to take under these enrichment contracts was to deliver uranium on schedule.

Having signed up for future enrichment services, the utilities rushed out into the uranium market to contract for the uranium they were obligated to deliver under their enrichment contracts. The rest is history.

Please note that two of the four items noted above are government actions—the embargo of foreign-origin uranium and the revision of enrichment policy. Thus, government enrichment policy artificially inflated uranium demand to levels totally inconsistent with actual utility needs. The situation was aggravated by supply constrictions caused by the embargo. Small wonder that prices rose. They reached $25 per pound U_3O_8 by early fall of 1975, when they were given new impetus by the Westinghouse affair, and accelerated further, reaching $40 in early 1976. They remained over $40 through the end of 1979.

The US government inadvertently accomplished what the foreign cartel had been singularly incapable of doing—namely, an increase in uranium prices. Everyone in the US wanted to get on the gravy train. Production soared. Meanwhile, actual demand was falling. The crash was inevitable.

The Three Mile Island incident in March 1979 was a watershed event. TMI probably didn't cause anything to happen that would not have otherwise happened in time. Indeed, high interest rates, escalating costs, regulatory delays and above all low electricity growth rates had set the stage for structural changes in the nuclear industry. And while delays and cancellations had occurred prior to March 1979, it is now clear that TMI caught the attention of people in the executive suite as had no previous event. It focused concerns and catalyzed action. A trickle of deferrals and cancellations became an avalanche. Large nuclear utilities became small nuclear utilities, and small nuclear utilities packed it in completely. Non-nuclear utilities had little need for uranium. Utility inventories were liquidated into an already glutted market and prices plunged.

Despite this situation, the momentum caused by earlier events resulted in continuing increases in US production. Uranium demand was based not on what reactors needed but on a web of interlocking contracts with the enrichment contract being the linchpin. The resultant situation is illustrated in Figure 1.

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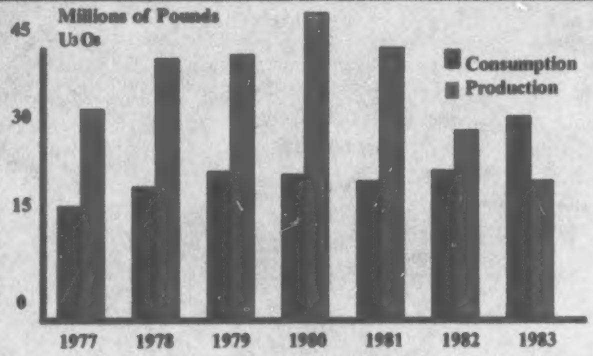

Figure 1

The astonishing thing is that in each year through 1980, production was essentially twice consumption and not until 1983 will US consumption exceed US production. Somewhere along the way we took our eyes off the target. We forgot what the utilities were actually doing—cancelling and deferring reactors. We were mesmerized by phony demand based on contracts that had nothing to do with real demand. Now we are paying the price. An enormous amount of inventory has already been liquidated, but there are still enormous quantities awaiting liquidation. It is difficult to be bullish on uranium prices while this inventory overhangs the market and production continues to exceed consumption worldwide.

Foreign Influences

The domestic uranium market is indeed subject to foreign influences, and, as the title of this paper suggests, the single most important of these influences is grade. I will have more to say about grade later, but would first note a counter-influence, namely, the unique legislative position enjoyed by US uranium miners. To my best knowledge, only uranium is protected by such congressional mandate. Specifically, the Atomic Energy Act requires the Secretary of Energy to insure the viability of the domestic uranium industry. Originally the primary means to accomplish this end was to control the amount of foreign uranium that US utilities could deliver to DOE for enrichment. 1973 regulations set this amount at zero for the years prior to 1977, 10 percent in 1977, 15 percent in 1978 increasing gradually to 80 percent in 1983 with no limit in 1984 and later. The events of the past two years have led to a new consideration of the viability of the US uranium industry, with particular emphasis on the level of foreign imports. Whether the US industry *should* or *will* be protected are separate questions which I'll discuss later.

Let me digress for another moment to identify the main foreign players. They are Canada, Australia, South Africa, Namibia, Niger, Gabon, and France. Canada is now the strongest player. While US production has declined from over 40 percent of world production to less than 15 percent, Canada's share has grown from 21 percent to 31 percent. Each of these countries, however, has its own peculiarities.

Canada essentially has two different industries, one in the east and one in the west. The old, eastern part is characterized by deep, underground, low-grade, high-cost reserves developed years ago. The new, western part, located in northern Saskatchewan, is characterized by very high-grade, relatively shallow deposits, high capital costs and low operating costs. Canadian production far exceeds the uranium needs of Canada's nuclear power program. The terms and conditions of uranium export sales are subject to government approval.

Australia has two active producers, Queensland Mines and Energy Resources of Australia (ERA). Australia's proven reserves are enormous, in excess of two billion pounds. Potential is still largely untapped. Development of a credible Australian uranium industry has been hampered by the continuing vacillation of government policy. The federal government must approve all export sales, and current policy requires floor prices which are now in excess of $30 per pound U_3O_8.

South Africa's uranium production nearly all comes as a by-product of gold mining. Production has historically been about 16 percent of the world total. Marketing is consolidated and handled by NUFCOR. Government approval is required for export sales, but government involvement is less than that found in Canada and Australia. Direct sales of U_3O_8 to US utilities are difficult due to perceived political problems. South Africa's delivery record, reliability and product quality are, however, probably the best in the world.

Namibia is the site of the Rossing mine, which annually produces nearly 10 million pounds U_3O_8. Political uncertainties will probably inhibit any further near-term development in this country, but Rossing is safe due to its importance as an earner of foreign exchange.

Niger has two operating mines and extensive additional reserves. French interests dominate, and the government is a major participant in both projects. Uranium is an important earner of foreign exchange, and, accordingly, production levels are somewhat less sensitive to prices.

Gabon is also closely tied to France, and is a relatively small producer with substantial government involvement.

France has a number of active uranium projects but is not an exporter, using all of its production to fuel an ambitious nuclear power program.

I mentioned earlier that grade was the most important foreign influence, and that can hardly be overstated. During the past four years the average grade of uranium ore mined in the US has ranged between 0.11 percent and 0.12 percent, or about 2 to 2.5 pounds U_3O_8 per ton of ore. Compare this with the two active Australian projects. The ore grade from Queensland Mines' Nabarlek mine averages over 2.36 percent. ERA's Ranger deposit has reserves in excess of 200 million pounds U_3O_8 with grade better than 0.30 percent. Or compare American ore with Saskatchewan's Key Lake deposit (2.5 percent reserves), and the multitude of other high-grade discoveries in the same geologic environment. These deposits are in remote areas and require substantial investment in in-

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frastructure, but with that kind of size and grade it is possible to build roads and towns and still be very price competitive.

It has been suggested that the US uranium industry is disadvantaged further because of strict environmental constraints imposed on it. While not an expert in this field, I must note that environmental constraints in both Australia and Saskatchewan are also strict, and if foreign producers do have an advantage in this area, it is insignificant compared to the advantages they enjoy as a consequence of size and grade.

Persistence of the US Uranium Industry

With all this emphasis on grade, size and resultant low costs, it is reasonable to ask why the current and future situation for the US uranium industry is not bleaker than we indicate. The answer is found in the nature of the utility buyer and the nature of the foreign supplier market.

First, and with respect to utilities, it must be observed that they are perhaps the most conservative business enterprises in existence. Risk aversion is a guiding policy, and risk aversion translates into concerns about security of supply. Too much, too soon may not be desirable, but it is certainly preferable to too late or too little. Source diversity is one approach to achieving security of supply, and can include multiple domestic as well as international suppliers. Price is important, but less so than security of supply.

It would be most unusual to see a US utility put all of its eggs in one foreign basket no matter what the price incentive were to do so. I know of some US utilities that have put half of their eggs in a foreign basket because of price attractions. But there are others that do not even consider foreign supply.

This may not make economic sense. The logical approach, one might reason, is for the United States to leave its low-grade, high-cost uranium in the ground as an insurance policy, and to buy low cost material from Australia, Canada and South Africa. This scenario has not and will not come to pass. US utilities will not buy 100 percent of their needs from foreign producers.

Second, note that the foreign supply market is highly concentrated. Excluding the United States, 87 percent of world production is found in four areas: Australia, Canada, Central Africa and South Africa. Each region has its own particular set of problems that lends slight unpredictability to future commitments. Furthermore, all of these foreign suppliers are bound by government involvement in the commercial aspects of the business—particularly pricing.

It is indeed ironic that only in the United States, home of low-grade, high-cost production, are producers free to do whatever they choose commercially, including going broke. Thus, we find that Cogema, the French nuclear fuel cycle company, has purchased 80 percent of Pathfinder Mines, Utah International's uranium unit. Why? With the largest percentage national commitment to nuclear power, the French are seeking diversity in the most politically stable market. And the French took this action even though they already had similar equity positions in Canada, Gabon, Niger and Namibia, and long-term supply arrangements with Australia and South Africa.

Similarly, over the past few months we have seen new interest by other overseas buyers in US uranium. It is too early to tell if these discussions will mature into definite contracts. It is my judgment, however, that these buyers are responding to the conditions that motivated Cogema.

Thus, despite its current depressed condition, reports of the death of the US uranium industry are greatly exaggerated.

Summary

At one time nuclear energy seemed to be the answer to the world's energy problems, both in the US and abroad. Suppliers of supporting products and services uncritically accepted overly optimistic forecasts; the US government's enrichment policy was a particularly important reflection of the prevailing attitude. With enrichment contracts driving demand, uranium prices soared and production expanded rapidly. Economic and regulatory constraints followed by reduced load growth led to a wave of nuclear cancellations and deferrals, particularly in the United States. Utilities liquidated their excessive uranium inventories into the market in direct competition with primary suppliers. Prices fell so low that some producers shut down operations and bought the uranium they needed to supply their long-term contracts. The price break also provided low-cost foreign sellers the opportunity to gain market share, as US producers could no longer compete economically. The US uranium industry went into a dramatic decline, marked by close-downs and wholesale withdrawals from the business.

Although current US production is only half what it was in 1980, it is a leaner industry in better shape to survive. And although the US is handicapped by higher costs and smaller orebodies, the uranium industry will survive because domestic and foreign utilities alike value the United States for its free market system and its political stability.

There is no need for an embargo to protect the US industry. The initial reasons for an embargo were weapons-related and linked to a concern that uranium was a scarce resource. We know better today. Although the grade is low, US resources are vast, and thus the only real concern is price. The near-term threat of cartel-like action by foreign suppliers (the feared UPEC) is a hollow one in a market characterized by oversupply and huge inventories.

The nuclear and uranium industries are both fully international. Interference with free market mechanisms can only be costly and disruptive. The major foreign influence, *grade*, will allow foreign penetration of the US market, but not dominance.

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MONTHLY REPORT ON THE NUCLEAR FUEL MARKET

December 1983 No. 184

R. WESLEY MILLER, *EDITOR* **JAMES J. LIGHTNER**, *ASSISTANT EDITOR*

PRICING

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To Our Readers

With this Report Nuexco introduces a new category of articles entitled *BASIC CONSIDERATIONS.* The articles presented under this category will address those readers for whom a review or an introduction to the terminology of the nuclear fuel cycle is useful. A related, specific intent of *BASIC CONSIDERATIONS* is to illustrate the effect of policies and markets of fuel cycle services on the business of natural uranium production. Because of the current emphasis on enrichment services and enriched UF_6, the first article of this series covers Separative Work Units (SWUs).

* * *

Included with this report is a copy of a speech entitled "The Uranium Market: Grade—Not Always A Crushing Experience," which Nuexco's president, Mr. George White, Jr., delivered to the Northwest Mining Association in Spokane, Washington on December 1. Reports 182 (October 1983) and 183 (November 1983) also contained speech inserts. In August, Mr. Jerry Reaves spoke at the Eighteenth Intersociety Energy Conversion Engineering Conference on "The Nuclear Fuel Cycle: Desperately In Need Of A Front End Alignment." On September 12, Nuexco's chairman, Mr. J.R. Wolcott, delivered a speech entitled "Megatrends In Nuclear Fuel: Approaching A New Era" at the Fourth Pacific Basin Nuclear Conference. In October, Mr. Donald Radcliffe presented a speech to the Society of Petroleum Engineers of AIME entitled "Another Comeback For Uranium." Also in October, at the Atomic Industrial Forum's Uranium Seminar in Santa Fe, New Mexico, Mr. George White, Jr., spoke on "The Fuelish Cycle: Markets For Excess Front-end Materials." If you did not receive a copy of one or more of these speeches with the Monthly Report, or if you would like additional copies, please contact our Menlo Park office.

* * *

Our offices will close for the Christmas holiday at noon on Friday, December 23, and will reopen on Tuesday, December 26. The offices will be closed for the New Year holiday on Monday, January 2, 1984.

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PRICING

NATURAL URANIUM

The **Exchange Value** as of November 30, 1983 is **$22.50** per pound U_3O_8, down $1.00 since last month. The *Current Market Data* section of this Report lists five uranium sales, involving approximately 6.2 million pounds U_3O_8, *equivalent*. All five transactions involved concentrates; two were for long-term deliveries.

Active supply of uranium for spot and near-term delivery totals **5.7 million** pounds U_3O_8 or equivalent UF_6. **Active demand** for spot and near-term delivery totals **3.1 million** pounds U_3O_8 or equivalent UF_6. The spot and near-term **supply-demand ratio** fell slightly to **1.8:1.**

The **Transaction Value** as of November 30, 1983 is **$23.85** per pound U_3O_8, up $0.20 from last month. The current Transaction Value includes 16 transactions involving a total of 2.3 million pounds U_3O_8 or equivalent UF_6 and covers a period of 5 months.

The **Loan Use Charge Rate** as of November 30, 1983 is **6 percent** per annum, unchanged since last month in this inactive market segment.

* * *

The Exchange Value fell $1.00 during November as sellers continued their efforts to stimulate buyer activity. Nevertheless, there was little near-term buying activity. Approximately half of the uranium actively for sale in the near term is in the form of natural UF_6, while active buyers in general have indicated a preference for concentrates. Sellers of natural UF_6 are leading the market with offers below recent Exchange Values. Amounts offered in some cases are large.

Producer buying has declined substantially over the past couple of years. As a consequence, the predominant buyer market consists of utilities that do not appear motivated to buy in advance of need, even at bargain prices. Two large transactions listed in this Report involve long-term deliveries from an Australian producer to US utilities. The execution of those transactions depends on the approval of the Australian uranium export office, which is expected, and on a rise in the market price for concentrates to a level near the Australian floor price.

SECONDARY MARKET CONVERSION SERVICES

The **Conversion Value** as of November 30, 1983 is **$0.60** per pound U as UF_6, unchanged since last month. No secondary market sales of conversion services are reported this month, reflecting the lack of activity in this market. Active secondary market supply of conversion services for delivery within three years totals 5.2 million pounds U as UF_6, while the corresponding demand figure is 1.3 million pounds.

* * *

The large active supply of UF_6 in the market has altered the conditions for spot purchases of conversion services over the past few months. In October the Conversion Value fell from $1.00 to the current level of $0.60. During November the lack of market activity made it difficult to judge the Conversion Value, but it was clear that conversion services could be acquired in the secondary market for very low prices.

SECONDARY MARKET ENRICHMENT SERVICES

The secondary market **SWU Values** as of November 30, 1983 are **$110 for DOE origin** and FY 84 delivery, and **$90 for non-DOE origin** and delivery within 15 months. The Value for DOE-origin SWUs fell $5 from last month while the Value for non-DOE-origin SWUs rose $5. The *Current Market Data* section of this Report lists eight SWU transactions involving a total of approximately 3.2 million SWUs. Four of those transactions involved large amounts of non-DOE SWUs to be delivered after 1985. Active secondary market supply of enrichment services totals 885 thousand SWUs, and active demand amounts to 620 thousand SWUs.

* * *

Last month, following DOE's issuance of the modified Interim Sales Contract (ISC) to holders of 3.5-year Requirements contracts, secondary market sellers of DOE SWUs increased their offering prices sharply, to the approximate level of $115, in anticipation of increased demand from takers of the new contract. (The modified ISC permits takers to buy some SWUs of DOE origin in the secondary market without assessment of the usual termination charge). During November demand did not expand as some sellers had expected. Sellers have lowered their offering prices to the approximate level of $110 to compete for a limited number of active buyers. However, prices are likely to continue to change as potential signers of the modified ISC make decisions about the contract.

During November DOE revised the language of the modified ISC to resolve a major concern of potential takers. One of the most important terms of the contract is

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the requirement that signers later convert to the Utility Services enrichment contract (USEC) when it is issued, *if* the terms of the USEC are no less favorable than the customer's 3.5-year Requirements contract. When announced on October 18, the modified ISC did not specify who will decide, when the USEC is issued, which contract type would be more favorable to the utility. The November revision is a clear statement that the customer will make that decision.

The clarification of terms of the modified ISC should increase the number of signers significantly. At least three US utilities and one non-US utility already have indicated plans to sign an agreement with DOE in the near future. Thus far only two US utilities have signed the ISC. Philadelphia Electric signed the original version to cover all three of its units and is likely to convert to the modified ISC. Commonwealth Edison elected to cover one unit with the modified ISC. Two Japanese utilities, Tokyo Electric Power and Kansai Electric Power, have asked DOE to prepare an original ISC to cover one reactor each.

* * *

The non-DOE SWU Value rose during November because of the depletion of 1984 SWUs offered by the most active sellers. Actual sellers' offering prices vary considerably; prices for large quantities of SWUs generally fall below the current SWU Value. The longer time period for delivery of non-DOE SWUs reflects the more flexible way in which sellers of non-DOE SWUs structure their offers. During November three European utilities cancelled commitments to take a total of 1.3 million SWUs at DOE from 1986-89 in order to buy non-DOE replacement SWUs in the secondary market.

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CURRENT MARKET DATA

EXCHANGE VALUE $22.50/lb. U_3O_8
Determined as of November 30, 1983

Definition[1]

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

[1] In December, 1981, Nuexco published a history of the Exchange Value which chronicled, month-by-month, changes in its definition, usage and derivation. Copies are available upon request.

TRANSACTION VALUE[2]
Determined as of November 30, 1983

$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
23.85	2.3	16	5

Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

Comments

Nuexco does not consider the following in determining the Transaction Value:

A. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.
B. The price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of Exchange Value or any other independent variable. Also excluded from consideration are all data where the delivery price is defined in such a way that it cannot currently be determined.

[2] Transaction Values for 1976 through 1981 and their associated parameters (millions of pounds, number of transactions and number of months) are tabulated on pages 31 and 32 of Report 161. Corresponding data for 1982 are tabulated on page 5 of Report 173.

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CURRENT MARKET DATA

LOAN USE CHARGE RATE[1] 6%
Determined as of November 30, 1983

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:
A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

[1] Monthly data for 1968 through 1981 appear on pages 32-34 of Report 162. Monthly data for 1982 appear on page 2 of Report 173.

CONVERSION VALUE[2] \$0.60/lb. U as UF_6
Determined as of November 30, 1983

Definition

The Conversion Value is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the last day of the month.

Derivation

Nuexco bases the Conversion Value upon:
A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Conversion Value:
A. The price of conversion services delivered or to be delivered under old contracts.
B. The price of conversion services delivered in connection with contract renegotiations or other than arm's length transactions.
C. Transportation charges other than those customarily provided by primary suppliers of conversion services.

[2] Monthly data for 1981 and 1982 are tabulated on page 6 of Report 173.

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SWU VALUES

$110/SWU FOR DOE ORIGIN AND FY84 DELIVERY
$90/SWU FOR NON-DOE ORIGIN AND DELIVERY WITHIN 15 MONTHS
Determined as of November 30, 1983

Definition

The SWU (Separative Work Unit) Values represent Nuexco's judgment of the prices, expressed in US dollars per SWU, at which transactions for the sale of significant quantities of SWUs of stated origins could be concluded as of the last day of the month.

Derivation

Nuexco bases the SWU Values upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.
E. SWU prices at varying tails and varying product assays are converted to the equivalent SWU price at the DOE Reference Transaction Tails Assay (presently 0.20 weight percent U_{235}) and a product assay of three percent U_{235} assuming feed costs calculated using the Nuexco Exchange Value and Nuexco Conversion Value determined as of the last day of the same month.

Comments

Nuexco does not consider the following in determining the SWU Values:

A. The price of SWUs delivered under long-term contracts from primary suppliers, such as DOE, Urenco, or Eurodif.
B. The price of SWUs delivered under other than arm's length transactions.

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CURRENT MARKET DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
Australia (dollar)	24.68	54.40	64.15
Belgium (comm. franc)	1,236	2,725	3,214
Canada (dollar)	27.90	61.51	72.54
Finland (markka)	130.51	287.73	339.30
France (franc)	185.64	409.27	482.63
FRG (mark)	61.06	134.61	158.74
Italy (lira)	36,885	81,318	95,893
Japan (yen)	5,276	11,630	13,715
Netherlands (guilder)	68.41	150.82	177.85
South Africa (rand)	26.41	58.22	68.66
Spain (peseta)	3,507	7,731	9,117
Sweden (krona)	179.57	395.88	466.84
Switzerland (franc)	48.96	107.93	127.27
UK (pound)	15.42	34.00	40.09
US (dollar)	22.50	49.60	58.50

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
Australia (dollar)	26.16	57.67	68.00
Belgium (comm. franc)	1,310	2,889	3,407
Canada (dollar)	29.58	65.20	76.89
Finland (markka)	138.34	304.99	359.66
France (franc)	196.78	433.83	511.59
FRG (mark)	64.72	142.69	168.26
Italy (lira)	39,098	86,197	101,647
Japan (yen)	5,592	12,328	14,538
Netherlands (guilder)	72.51	159.87	188.52
South Africa (rand)	27.99	61.71	72.78
Spain (peseta)	3,717	8,195	9,664
Sweden (krona)	190.34	419.63	494.85
Switzerland (franc)	51.89	114.40	134.91
UK (pound)	16.35	36.04	42.50
US (dollar)	23.85	52.58	62.00

[1] Calculated using currency exchange rates published in the Wall Street Journal on November 30, 1983.

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CURRENT MARKET DATA

CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U as UF_6	per kg U as UF_6
Australia (dollar)	0.66	1.45
Belgium (comm. franc)	32.97	72.68
Canada (dollar)	0.74	1.64
Finland (markka)	3.48	7.67
France (franc)	4.95	10.91
FRG (mark)	1.63	3.59
Italy (lira)	983.61	2,168
Japan (yen)	140.68	310.15
Netherlands (guilder)	1.82	4.02
South Africa (rand)	0.70	1.55
Spain (peseta)	93.52	206.17
Sweden (krona)	4.79	10.56
Switzerland (franc)	1.31	2.88
UK (pound)	0.41	0.91
US (dollar)	0.60	1.32

SWU VALUES EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU FY84	Non-DOE SWU delivery within 15 months
Australia (dollar)	120.64	98.71
Belgium (comm. franc)	6,044	4,945
Canada (dollar)	136.41	111.61
Finland (markka)	638.05	522.04
France (franc)	907.59	742.57
FRG (mark)	298.51	244.23
Italy (lira)	80,328	47,541
Japan (yen)	25,791	21,102
Netherlands (guilder)	334.45	273.64
South Africa (rand)	129.11	105.63
Spain (peseta)	17,145	14,027
Sweden (krona)	877.89	718.28
Switzerland (franc)	239.34	195.82
UK (pound)	75.39	61.69
US (dollar)	110.00	90.00

[1] Calculated using currency exchange rates published in the Wall Street Journal on November 30, 1983.

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CURRENT MARKET DATA

RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
2562	1984	301-600	105	US Producer	US Utility	
2575	1985-92	3,000-5,000	indeterminate	Australian Producer	US Utility	Additional 1 million lbs. optional. Pending approval for export.
2576	1986-96	1,500-3,000	indeterminate	Australian Producer	US Utility	Option to take in 1984-85. Pending approval for export.
2583	1985	101-300	111	US Producer	US Utility	
2584	1984-85	50-100	104	US Producer	US Producer	

Secondary Market Enrichment Services

Nuexco Transaction Number	Delivery Period[2]	Approximate Quantity (thousands of SWUs)	Approximate Price[3] as Percent of Current SWU Value[4]	Tails Assay (Percent U_{235})	Seller Group	Buyer Group	SWU Origin	Remarks
2534	1984	50-100	85	.2	European Entity	US Utility	DOE	
2535	1984	less than 50	101	.2	European Utility	US Utility	DOE	
2549	1984-85	601-1,000	89-92	to be specified	European Entity	US Utility	Eurodif	
2570C	1986-89	301-600	indeterminate	to be specified	European Entity	European Utility	Eurodif	
2570B	1986-89	301-600	indeterminate	to be specified	European Entity	European Utility	Eurodif	
2570A	1986-89	301-600	indeterminate	to be specified	European Entity	European Utility	Eurodif	
2571	1986-89	601-1,000	indeterminate	to be specified	European Entity	European Entity	Eurodif	
2582	1984	less than 50	104	.2	European Entity	US Utility	Eurodif	

[1] Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.
[2] Refers to quarter of calendar year, not fiscal year.
[3] Price is not normalized to 0.20% tails assay.
[4] Comparison to SWU Value for same origin as SWUs included in transaction.

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URANIUM SUPPLY
(As of 11/30/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
1575	—	500 per year	1985-92
1818	—	500 per year	1984-90
2038	2,000	—	UF_6
2134	—	250 per year	1984-87
2201	300	—	
2203	1,000	—	
2220	150	—	UF_6
2235	—	150 per year	1985-89
2236	—	200 per year	1985-89
2263	—	500 per year	1985-90
2274	—	600 per year	1985-91
2275 A	100	—	
2297	60	200 per year	1985-89
2307	340	—	UF_6
2315	170	950	UF_6
2336	250	250 per year	1985 on
2365	20	—	
2366	600	—	
2376	200	—	U_3O_8 or UF_6
2429	450	—	
TOTAL:	5,720		
INACTIVE			
2017	1,100	1,200	
2271	—	500 per year	1984-85
2191	125	—	UF_6
2193	—	800 per year	1986-90
2309	950	—	
TOTAL:	2,175		

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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CURRENT MARKET DATA

URANIUM DEMAND
(As of 11/30/83)

	Delivery Period[1] (Thousands of Pounds U_3O_8)		
Nuexco Project Number	**Spot or Near-term[2]**	**Intermediate or Long-term**	**Remarks**
Inquiries to Purchase: ACTIVE			
1459	—	200 per year	1988 on
2025	420	350	
2167	250	250 per year	1984-89
2233	700	—	U_3O_8 or UF_6
2266	450	—	
2304	—	500 per year	1987 on
2310	800	—	enriched UF_6
2313	260	255	1985
2329	—	500	1985
2357	130	—	enriched UF_6
2372	—	250 per year	1985-88
2416	—	430	
2413	—	250 per year	1986-88
2419	50	—	
TOTAL:	3,060		
INACTIVE			
1999	—	50 per year	1985-90
2118 A	250	—	
2244	—	350 per year	1985 on
2302	—	250 per year	1987 on
2360	270	—	enriched UF_6
2371	—	260 per year	1984-90 UF_6
2414	—	100 per year	1987-91 U_3O_8 or UF_6
TOTAL:	520		

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[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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LOAN SUPPLY AND DEMAND
(As of 10/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Within 1 Year	Beyond 1 Year	Remarks
Available for Loan:			
ACTIVE			
1815	1,000	—	UF_6
1938	1,500	—	UF_6
2128	1,000	—	
TOTAL:	3,500		
INACTIVE			
1884	600	—	
2036	500	—	UF_6
2139	2,000	—	
TOTAL:	3,100	—	
Inquiries to Borrow:			
ACTIVE			
2118	250	—	U_3O_8 or UF_6
TOTAL:	250		

[1] Measured from the date of this Report.

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CURRENT MARKET DATA

CONVERSION SUPPLY
(As of 11/30/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF_6)		Remarks
	Within 3 Years	Beyond 3 Years	
ACTIVE			
2051	1,500	—	
2141	1,500	—	
2143	200	—	
2220	210	—	
2222	80	175	
TOTAL:	3,490		
INACTIVE			
1609	1,500	—	
1936	1,500	—	
2181	1,300	650 per year	1985-90
2230	300	—	
2401	600	—	
TOTAL:	5,200		

CONVERSION DEMAND
(As of 11/30/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF_6)		Remarks
	Within 3 Years	Beyond 3 Years	
ACTIVE			
2380	700	—	
2386	330	—	
2420	300	—	
TOTAL:	1,330		
INACTIVE			
2194	—	300 per year	1986 on
2287	—	250 per year	1986 on
2295	200	—	
TOTAL:	200		

[1] Measured from the date of this Report.

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SWU SUPPLY
(As of 11/30/83)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
1895	—	1,000	
2100	—	200	
2164	120	—	
2192	—	430	
2201	85	80	1985
2210	—	150	1985
2285	500	3,000	
2345	—	500	1985
2351	—	150 per year	1985-91
2359	180	—	
2378	—	120 per year	1985-89
2408	—	120	1985
2428	—	200	1985
TOTAL:	885		
INACTIVE			
2137	80	80 per year	1984 on
2337	250	250	
2375	200	—	
TOTAL:	530		

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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CURRENT MARKET DATA

SWU DEMAND
(As of 11/30/83)

	Delivery Period[1] (Thousands of SWUs)		
Nuexco Project Number	Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2233	250	—	
2272	—	200	
2282	—	300	
2310	200	—	
2355	—	180 per year	1986,88,90,92
2362	150	—	
2400	—	85	1985
2410	20	—	
2412	—	80	1985
TOTAL:	620		
INACTIVE			
2142	—	35	1985
2237	—	250 per year	1985 on
2418	—	100	1987

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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RECENT DEVELOPMENTS

ARGENTINA

In November the government announced that a gaseous diffusion enrichment plant near Pilcaniyeu in the southern mountain region is operating successfully. The plant, which will produce at full capacity in 1985, costed $62.5 million. Planning for it began in 1978 after the US government refused to sell Argentina enriched uranium for its research reactors. With the recent announcement an Argentine spokesman commented, "The great power's policy of not providing technology to developing countries has proved unsuccessful."

Argentina's Nuclear Energy Commission is also building a reprocessing plant that is scheduled to open in 1986. The country has had only one commercial reactor operational since 1974, Atucha 1, a 335 MWe PHWR provided by Kraftwerk Union (KWU) and located near Buenos Aires. One other government-owned unit, Embalse, a 600 MWe CANDU, reached criticality in February of this year and should begin commercial operation in 1984. The country's third unit, Atucha 2, a 692 MWe PHWR supplied by KWU, is approximately 25 percent complete and will probably be operational in the early 1990s.

AUSTRALIA

Report 183 (November 1983) lists the four main points of the Labor (ALP) government's uranium policy, which was approved in November by the ALP parliamentary caucus by a vote of 55 to 46.

1. The most important development was the approval of future uranium export from the Olympic Dam project at Roxby Downs Station in South Australia (see this Report's *Raw Materials* section).
2. No new uranium projects other than Olympic Dam may be developed.
3. Existing export contracts for Australia's two operating projects, including the two contracts recently negotiated with US utilities, will be honored, although an existing contract with a French utility will continue to be suspended for nuclear weapons-related reasons.
4. No new contracts may be approved until an inquiry by the Australian Science and Technology Council into international non-proliferation safeguards and technologies for waste disposal is concluded five months hence, in May 1984.

The ALP decision reflects a compromise between extreme Labor ideology and economic sense. A government analysis sets the maximum potential for annual contracts at approximately 3 thousand tonnes U_3O_8 for 1985-90. That level of demand, according to one official, makes Olympic Dam and other projects awaiting development "at best competitive and at worst mutually exclusive." Consequently, the potential loss of revenue associated with restricting development was outweighed by political consolation gained from the anti-uranium measures. Olympic Dam escaped the prohibition on new uranium mining mainly because its development is vital for the South Australian economy. A veto of the project would have meant the demise of the ALP in South Australia.

Nationwide, a more severe curtailment of the uranium industry than that set forth would have had serious implications for the national economy and for Australia's reputation as a trading nation. While approval for any new contracts will not be granted for at least five months, Ranger and Nabarlek may still attempt new sales. Their success in the market is largely dependent on the behavior of the spot price in relation to the Australian floor price, which is currently near the $35 level.

The Australian Labor Party is likely to remain in control of the federal government for several years, probably through 1988. No significant change in uranium policy should be expected until at least the end of the decade. Therefore, allowing for a three to four-year construction period for new mines, no uranium deliveries from any potential Australian projects should be expected before 1993. The commercial viability of the one ALP-approved project, Olympic Dam, depends most on a growth in demand for copper, which is the primary ore mineral, but an up-turn in the price of uranium is also important. Uranium from Olympic Dam probably will not be exported before the early 1990s, although sales commitments will have to be made long before then to underwrite the $1.4 billion investment.

CHINA

Recently the People's Republic of China (PRC) approved an order for two 900 MWe PWRs at Daya Bay in the southern province of Guangdong. Financing had been the major obstacle to the planned $4.5 billion twin project, which is a joint endeavor of the PRC and Hongkong. China will hold a 75 percent stake in the plant while the remainder will belong to a consortium of Hongkong interests led by China Light and Power Company. 70 percent of the power output will be sold to Hongkong. The Guangdong units, which will be supplied by Framatome, should be completed in the early 1990s.

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RECENT DEVELOPMENTS

China became a member of the International Atomic Energy Agency on October 11, 1983, four months after construction began on the 300 MWe Quinshan reactor south of Shanghai, in Zhejiang province. The PRC's first nuclear reactor, designed and built domestically, Quinshan should be completed by 1990. Shanghai is located at the mouth of the Yangtze River and is China's most populous city with more than 11 million people.

NAMIBIA

In Report 182 (October 1983) the table on page 27 illustrating Nuexco's free world uranium production forecast shows Namibia's production starting to decline in 1985, falling to 6.5 million pounds U_3O_8 in 1987 and staying at that level into the early 1990s. Published reports had indicated that the United Kingdom's Central Electricity Generating Board (CEGB) would not extend its commitment to Namibia's Rossing operation beyond an existing contract's expiration in 1984. More recent information indicates that CEGB will continue to receive uranium from Rossing for several years. The uranium production forecast for Namibia has been revised accordingly in the updated free world uranium production forecast shown in Table 1.

TURKEY

Four vendors are known to be under consideration for the planned Akkuyu unit, the future of which is nonetheless in doubt because of uncertainties about financing. General Electric, CANDU, Kraftwerk Union, and TVA have been negotiating with the Turkish government about the country's first reactor. TVA may be offering the most competitive package as it is trying to sell its deferred Yellow Creek unit, which Combustion Engineering will provide. However, KWU is thought to have placed a bid of $1.067 billion for a 970 MWE PWR, which a GE official said his company "can't beat."

The reactor order is unlikely to take place in the near future despite the interest the government is expressing to potential vendors. The recent election of a civilian government marks the beginning of a period of transition in which no significant policy decisions are likely to take place. Furthermore, the existence of a viable financing scheme is far from certain, although there are indications that KWU may include a substantial capital loan in its proposal. Even if the Akkuyu order is placed within the next year, nuclear fuel needs will not emerge until at least the end of the decade.

Table 1

FREE WORLD URANIUM PRODUCTION FORECAST
(millions of pounds U_3O_8)

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Canada	20.9	24.9	32.1	31.4	31.9	31.9	31.9	31.9	31.6	31.6
United States[1]	19.7	15.0	15.3	17.1	17.2	18.2	18.3	20.9	22.5	22.3
Australia	10.5	10.5	10.5	10.5	10.5	9.2	8.0	10.0	12.8	17.6
South Africa	15.6	16.3	16.8	17.0	17.1	17.3	17.5	17.4	17.4	17.0
Namibia	9.8	10.0	10.0	10.0	8.5	8.5	8.5	8.5	8.5	8.5
Central Africa[2]	11.2	10.2	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7
France	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Other Nations[3]	2.4	2.8	2.8	2.9	2.9	2.9	2.7	2.4	3.1	3.8
TOTAL FREE WORLD[4]	98	98	105	107	106	106	105	109	114	117

[1] US production forecast updated in Report 183 (November 1983).
[2] Niger and Gabon.
[3] Argentina, Belgium, Brazil, Chile, Mexico, Portugal, Spain and others.
[4] Rounded to the nearest million pounds U_3O_8. Report 182 lists the total for 1992 incorrectly as 119.

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SEPARATIVE WORK UNITS

Introduction

The manufacture of nuclear reactor fuel follows five primary steps:

1. Extraction of uranium ore;
2. Milling of ore to form natural uranium concentrates (commonly referred to as U_3O_8);
3. Conversion of concentrates to uranium hexafluoride (UF_6);
4. Enrichment of UF_6 to increase the concentration of fissionable U_{235} atoms in the product;
5. Fabrication of enriched UF_6 into solid uranium dioxide (UO_2) pellets designed to meet individual reactor core specifications.

Of these five steps, step 4, the process of enriching UF_6, is the most expensive. It involves the use of highly sophisticated equipment that, with the current technology, requires large amounts of electricity to operate. A **Separative Work Unit,** or **SWU,** is an indirect measurement of time and energy (work) used in the enrichment process.

The Enrichment Process

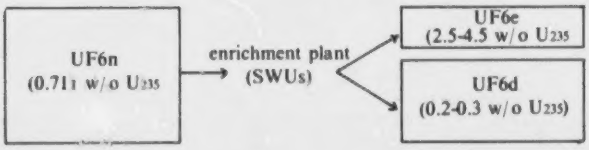
The enrichment process is schematized simply in Figure 1, which illustrates the equation:

$$UF_6n + SWUs = UF_6d + UF_6e$$

where UF_6n is *natural* UF_6 (feed), UF_6d is *depleted* UF_6 (tails), and UF_6e is *enriched* UF_6 (enriched product).

Figure 1

THE ENRICHMENT PROCESS

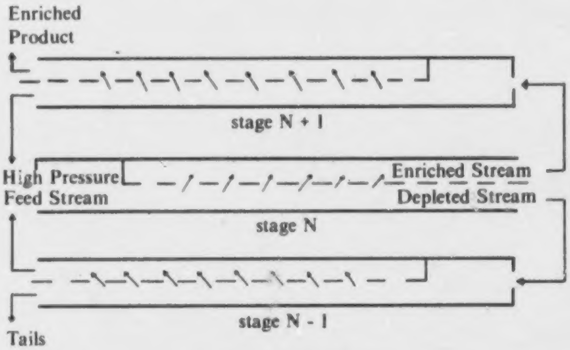


In the natural UF_6 that arrives at an enrichment plant as feed, the content of U_{235}, the fissionable light isotope of uranium, is normally 0.711 weight-percent (w/o). For most commercial applications, the enrichment process increases the U_{235} content to between 2.5 and 4.5 w/o. To achieve this higher proportion of U_{235}, enrichment processes physically separate the lighter component from the heavier components of the natural UF_6. The principal technology used to enrich the UF_6, **gaseous diffusion,** has been in use in the US for more than thirty years. Three other technologies exist, gas centrifugation, aerodynamic processes, and laser processes; several countries are developing **gas centrifugation** on a large scale.

Diffusion and centrifugation processes both separate UF_6 by exploiting the lighter atomic weight of U_{235} compared to U_{238}. The diffusion process, depicted in Figure 2, involves running the UF_6 feed at high pressure through a porous material, which allows the lighter (U_{235}) portion of the gas to escape and collect. The main portion of the feed, which becomes severely depleted of U_{235} after multiple passes through the system, is called **tails.** The small fraction of U_{235} retained in the tails is called the **tails assay** and normally falls between 0.2 and 0.3 w/o, as compared to the 0.711 w/o of the natural feed. The drawn-off portion of the UF_6, which contains a higher concentration of U_{235}, is called **enriched product.** The fraction of U_{235} in it (typically between 2.5 and 4.5 w/o for commercial applications) is called the **product assay.**

Figure 2

ENRICHMENT BY GASEOUS DIFFUSION



The centrifugation process uses less electricity per unit of output for separation of UF_6 than does the diffusion process, but the application of centrifuge technology to uranium enrichment is comparatively recent. Centrifuge technology, illustrated in Figure 3, involves the high-speed spinning of UF_6 feed to induce separation of heavy and light components. The heavier (depleted) elements in the feed are drawn by gravitational and rotational forces toward the bottom of the centrifuge, while the lighter (enriched) portion is "scooped" from the upper end of the machine.

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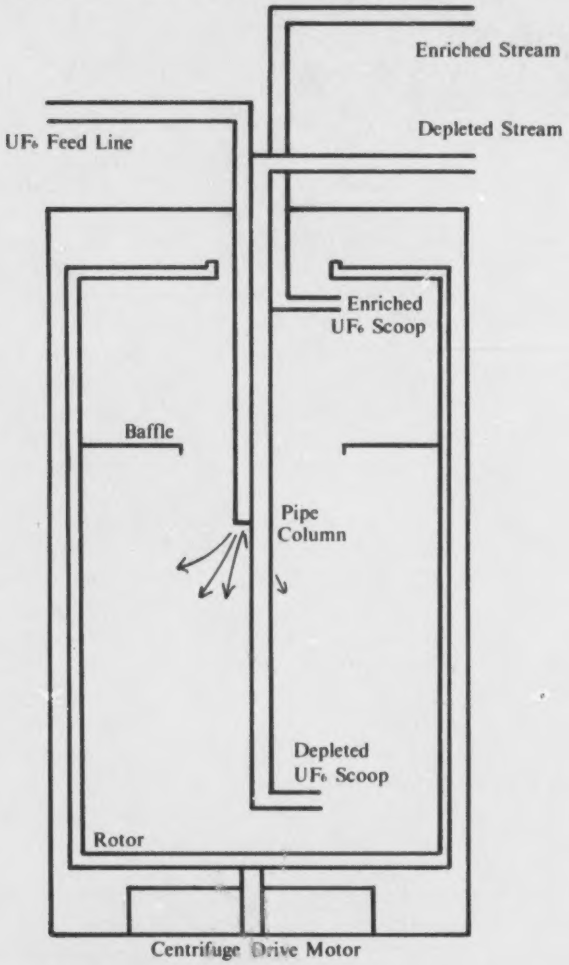
BASIC CONSIDERATIONS

Figure 3

ENRICHMENT BY GAS CENTRIFUGATION



Importance of the Tails Assay

At the end of the enrichment process the amount of depleted UF_6 (tails) greatly exceeds the amount of enriched UF_6 (enriched product); the ratio may be between 4:1 and 8:1. In general, a relatively low ratio of tails to enriched product indicates a lower tails assay (closer to 0.2 weight-percent). Therefore, for generation of a fixed quantity of enriched product, a lower tails assay requires less UF_6 feed. To achieve a lower tails assay, however, requires more SWUs. As the tails assay decreases, the number of additional SWUs necessary to draw off a given increment of U_{235} from already-depleted UF_6 increases.

An example of two enrichment alternatives illustrates the mathematics of the process and the importance of the tails assay. Assume that a utility needs to send to its fabricator 20 thousand KgU in enriched UF_6 with a product assay of 3.4 percent. In order to obtain that enriched product, the utility must buy some quantity of natural UF_6 and enrich it with some quantity of SWUs. The utility may consider several ways to achieve the same end result, two of which are depicted in Table 2.

Table 2

EFFECT OF TAILS ASSAY ON COST OF ENRICHED PRODUCT

	Alternative 1	**Alternative 2**
Tails Assay	0.2	0.3
UF_6 Feed @ $64/KgU	125 MtU ($8,000,000)	150 MtU ($9,600,000)
SWUs @ $138.65/SWU	105 ($14,558,250)	85 ($11,785,250)
Enriched Product	20 MtU ($22,558,250)	20 MtU ($21,385,250)
	Cost Difference = **$1,173,000**	

Alternative 1: Order a tails assay of **0.2 w/o** from the enrichment facility, supply the facility with approximately **125 thousand KgU** in natural UF_6 (325 thousand pounds U_3O_8 equivalent), and buy approximately **105 thousand SWUs.**

Alternative 2: Order a tails assay of **0.3 w/o** from the enrichment facility, supply the facility with approximately **150 thousand KgU** in natural UF_6 (390 thousand pounds U_3O_8 equivalent), and buy approximately **85 thousand SWUs.**

In either alternative, the utility meets its requirements of 20 thousand KgU in enriched product. The cost difference between the two alternatives could be quite substantial, however. The utility's choice boils down to the difference between the cost of 20 thousand SWUs and the cost of 25 thousand KgU in UF_6n. If the cost of SWUs is $138.65 per SWU (DOE price for fixed-commitment contracts) and the cost of feed is $64.00 per KgU in UF_6 (approximate market value of UF_6 as of November 1983), the cost difference between Alternative 1 and Al-

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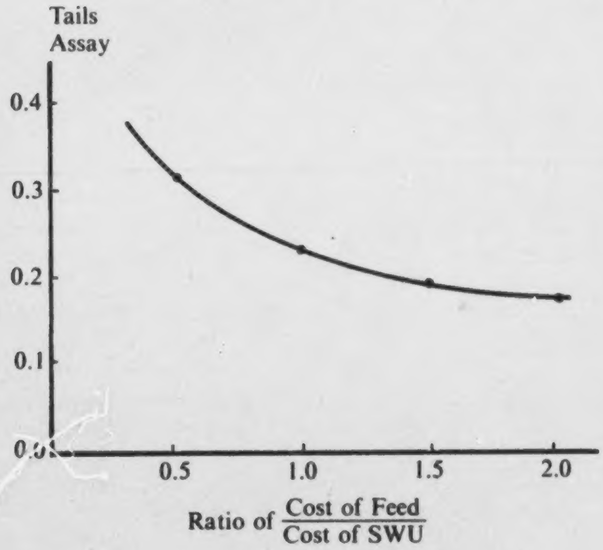
ternative 2 is (20,000 x 138.65) - (25,000 x 64.00) = $1,173,000. Alternative 2 could reduce the utility's costs by almost $1.2 million.

Most enrichment contracts do not allow utilities to choose the tails assay, but leave the designation to the enrichment supplier. When the tails assay is fixed the price of enriched product is constant. Most contract types set the tails assay near the level of 0.2 weight-percent because the lower tails reduces the accumulation of depleted UF_6 at the enrichment facility and enforces maximum SWU production for a given requirement in enriched product. One contract offered by the US Department of Energy (DOE), the Adjustable Fixed-Commitment (AFC) contract, does allow the customer to specify the tails assay in the range of 0.16-0.3 w/o. The contract provision is termed the Variable Tails Assay Option (VTAO). By exercising the VTAO, those customers with AFC contracts can obtain the **optimum tails assay,** the weight-percent in U_{235} which most reduces the cost of enriched product. Or they can adjust the tails assay to take delivery of a committed number of SWUs without excess enriched product.

Figure 4 shows the optimum tails assay curve, in which the tails assay is plotted against the ratio of the cost of UF_6 feed to the cost of SWU. As that ratio decreases, the optimum tails assay increases. In the example shown in Table 2 the ratio of feed cost to SWU cost is 0.46, so the optimum tails assay is just above 0.3 w/o.

Figure 4

OPTIMUM TAILS ASSAY CURVE



Purchase of SWUs

Currently there are four **primary market** suppliers of SWUs. Cumulatively they have the capacity to produce 42 million SWUs per year. US DOE holds most of that capacity, approximately 27 million SWUs per year. Eurodif, a joint venture among Belgium, Italy, Spain, and primarily France, has the capacity for approximately 11 million SWUs per year. Techsnabexport in the Soviet Union can export approximately 3 million SWUs per year, while Urenco, a joint venture of Britain, the Netherlands and West Germany, has the capacity to produce 1 million SWUs with modern centrifuge technology. All nuclear utilities have long-term contracts with one or more of these suppliers to meet the fuel needs of their reactors.

Utilities can also buy SWUs from other utilities in the **secondary market.** Sellers of SWUs in the secondary market usually intend to dispense with unneeded contract commitments to primary enrichers and at the same time generate cash or reduce losses. There are various means of concluding a secondary market SWU transaction. Three typical and conventional transaction types are:

1. A *sale* of enriched product, whereby the buyer pays the seller entirely with cash;
2. A *deenrichment swap,* whereby the buyer pays for enriched product by returning to the seller the equivalent UF_6 feed plus cash for the SWUs;
3. A contract *assignment,* whereby the buyer pays the seller to assume the seller's contract obligations with a primary enricher.

Secondary market sellers of SWUs often are willing to offer very competitive prices for their SWU commitments because of the strong desire to liquidate unneeded assets. Consequently, utilities that still need SWU deliveries often find attractive opportunities to cancel limited contract obligations with primary enrichers and buy replacement SWUs in the secondary market.

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ANALYSIS

FORECAST OF SWU CONSUMPTION

Introduction

Details of Nuexco's most recent forecast of Separative Work Unit (SWU) consumption are presented in Table 3. Nuexco expects consumption to increase from a total of approximately 16 million SWUs in 1983 to 27.3 million SWUs in 1990.

Methodology

The SWU consumption forecast is a theoretical calculation of the SWUs which will be consumed for the operation of commercial nuclear power reactors outside communist areas. SWU consumption is a function of nuclear electric generating capacity, as is the future consumption of U_3O_8. The SWU consumption forecast is based on the same assumptions of reactor construction and operation as the forecasts of nuclear electric generating capacity and apparent future consumption shown in Report 182 (October 1983).

Three assumptions are particularly pertinent to the SWU consumption forecast.

1. The calculation assumes an average tails assay of 0.25 weight-percent (w/o) U_{235}. Tails assays in the future will depend on the theoretical optimum tails assay, which is a function of SWU costs relative to feed costs, and on the flexibility of enrichment suppliers with regard to tails specifications.

2. CANDU heavy water reactors and English gas-cooled reactors do not currently use enriched uranium, and therefore do not consume SWUs, although CANDUs are expected to utilize low-enriched reloads in the 1990s. Some breeder reactors use enriched uranium in initial fuel loads, but are subsequently fueled by natural uranium and self-generated plutonium.

3. The calculation includes an adjustment factor to reflect inefficiency in the actual burnup of LWR fuel in comparison to the theoretical optimum. Because of fixed reload schedules, more SWUs are consumed than theoretically necessary. Units often arrive at scheduled refueling outage windows without having fully consumed core fuel. The premature discharge of fuel reduces average burnup from design levels. Fuel mechanical failures also contribute to fuel inefficiency, but are currently of minor importance, and the forecast assumes that mechanical performance will continue to improve.

Table 3

FREE WORLD SWU CONSUMPTION
(thousands of SWUs)

BUYER GROUP	1983	1984	1985	1986	1987	1988	1989	1990
United States	6,549	7,198	7,873	9,591	9,733	10,386	10,583	10,455
Europe	6,733	7,842	9,000	9,441	8,712	10,399	10,718	11,559
Far East[1]	2,497	2,891	3,434	3,497	3,716	3,545	4,655	4,718
Other Nations[2]	267	172	259	392	321	329	751	570
TOTAL FREE WORLD[3]	16,050	18,100	20,570	22,920	22,480	24,660	26,710	27,300

1. Japan, South Korea, Taiwan, Philippines.
2. Argentina, Brazil, Mexico, India, South Africa.
3. Totals rounded to nearest order of ten.

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WEST GERMANY

Introduction

The first nuclear reactor was connected to West Germany's power grid in 1961, and the national utilities pursued an active nuclear research and development program through the early 1970s. In the mid-1970s, however, the nuclear power program came to a halt following violent anti-nuclear demonstrations at the site of the Wyhl nuclear plant. After a five-year "de facto" moratorium on nuclear power construction, the nuclear industry recently has regained momentum.

Hamburg
Berlin
EAST GERMANY
Bonn
WEST GERMANY
Stuttgart
Munich

Current Plan

A recent forecast indicates that electricity use will grow faster than use of any other energy form in West Germany. However, the country lacks base-load capacity for continuous low-cost generation. Germany is poor in energy resources, with significant domestic reserves only of hard coal, which is expensive to develop. As hydro and lignite have been exploited fully, nuclear power appears to be the best available alternative electricity source. A recent comparison of anticipated future costs for base-load power in France and West Germany suggests that increasing use of nuclear energy may cause substantial reductions in electricity costs. By the mid-1990s, base-load power in France, where nuclear power will represent up to 70 percent of electricity generating capacity, may cost half as much as in West Germany, where the nuclear share will represent up to 30 percent of capacity.

West Germany's Christian Democrat government wants to increase the use of nuclear power to cut energy dependence on the Soviet Block and Opec, and save low-cost lignite for synfuels development. It backs a "reasonable" buildup of nuclear power, professing a belief that safety provisions are adequate and nuclear waste problems have been solved sufficiently. Table 4 summarizes Germany's current nuclear program.

The Convoy System

The presence of six limiting factors led to the five-year de facto moratorium on nuclear plant construction in the mid-1970s.

1. A strong anti-nuclear movement;
2. Multiple federal and state licensing systems;
3. A complex, sequential licensing procedure at various steps of the construction process;
4. A lack of adequate waste storage and disposal facilities;
5. Undetermined reprocessing arrangements;
6. High vulnerability of utilities to court action.

To overcome some of the obstacles to nuclear development, Kraftwerk Union (KWU), in partnership with utilities, technical experts, and licensing authorities, developed the concept of licensing four or five standardized nuclear power stations in sequence, referred to as the "convoy" concept. KWU designed a basic 1300 MWe PWR, known as the "Construction Line 80," and established a three-step plan for installment of identical units at different sites.

1. Minimum requirements for component documentation would be clearly defined, and documents would be standardized for approval.
2. A single set of engineering documents would be valid for all projects.
3. Construction and commissioning of units would follow four steps:
    a. Construction of buildings;
    b. Mechanical and electrical component fabrication and erection;
    c. Completion of remaining site work;
    d. Loading of first core and nuclear commissioning.

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FOCUS

Table 4

COMMERCIAL NUCLEAR POWER STATIONS IN WEST GERMANY

Operational Reactors	**Utility**	**Type**	**Output (MWe net)**	**Commercial Operation**
Obrigheim	KWO	PWR	328	1969
Stade	NWK	PWR	630	1972
Wuergassen	PREAG	BWR	640	1972
Biblis A	RWE	PWR	1146	1975
GKN-1	GKN	PWR	810	1976
Brunsbuttel	HEW	BWR	771	1977
Biblis B	RWE	PWR	1240	1977
Unterwesser	NWK	PWR	1230	1979
KKP-1	Badenwerk/EVS	BWR	864	1980
Isar-1	Bayernwerk	BWR	870	1980
Grafenrheinfeld	Bayernwerk	PWR	1225	1982
Kruemmel	HEW	BWR	1260	1983
Total Operational (MWe net)			11,014	

Reactors Under Construction	**Utility**	**Type**	**Output (MWe net)**	**Percent Complete**	**Expected Commercial Operation**
KRB II Block B	RWE/Bayernwerk	BWR	1244	95	1984
THTR 300	HKG	HTR	296	90	1985
Grohnde	PREAG	PWR	1290	90	1985
KRB II Block C	RWE/Bayernwerk	BWR	1244	90	1985
KKP-2	Badenwerk/EVS	PWR	1268	90	1985
Kaerlich	RWE	PWR	1227	70	1986
SNR-300	SBK	LMFBR	295	70	1987
Brokdorf*	NWK/HEW	PWR	1290	50	1986
Isar-2*	Bayernwerk	PWR	1285	10	1988
Emsland*	VEW	PWR	1222	10	1989
GKN-2*	GKN	PWR	1230	15	1990
			11,891		

Planned Reactors					
Wyhl*	Badenwerk/EVS	PWR	1284	0	indefinite
Hamm	VEW	PWR	1300	0	indefinite
Biblis C*	RWE	PWR	1237	0	indefinite
Neupotz	RWE	PWR	1246	0	indefinite
Total Planned (MWe net)			5,067		

POSSIBLE NUCLEAR CAPACITY BY 1991 27,972

*Convoy units

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KWU expects implementation of the convoy concept to cut engineering man-hours spent on construction by 25 percent, to 2.4 million hours per 1300 MWe unit. With all engineering planning done in advance of an order, preplanning starts only 2.5 years prior to concrete pouring. Package orders can be placed with manufacturers with resulting savings from economies of scale.

The Federal Ministry for Internal Affairs remains responsible for technical assessment of nuclear projects, while state regulatory authorities grant final construction permits. In the convoy system, documents are identical except for the site-related features of each project. Design references for one project will be accepted for other convoy units, so expert examination can concentrate on site-specific issues.

The streamlining of nuclear plant construction has been supplemented by an apparent shift in the interpretation of laws that is lessening the occurrence of purely political delays caused by nuclear opponents. Reactor design changes in the interest of greater public safety no longer require public hearings. The attitude has become prevalent that the licensing of standardized units should not be hindered by public protests and lengthy court procedures.

Nuclear Utilities

In general, West German electric power companies are private enterprises and are run as such, although in many cases local governments hold a majority of the capital stock. Each electric power company has a monopoly in its area, but the country's Energy Supply Act requires each to meet its local demand at all times. Neighboring utilities need to keep prices in line with each other because the federal government has the authority to reassign municipalities in fringe areas from one utility to another if consumer prices vary significantly.

At least twelve utilities are operating, building, or planning nuclear plants. Utility ownership of units is often interconnected, as shown in Figure 5. The government is not involved in deciding the capacities of the power stations, allowing the free market system to determine energy supplies.

Uranium Supplies

Germany does not have significant uranium deposits of its own and consequently is dependent on imports. Historically West German utilities have depended heavily on long-term contracts with commitments for five or more years. South Africa is the principal foreign supply source, providing 40 percent of 1983 deliveries and two-thirds of the long-term foreign supply. The United States accounts for only a small portion of longer term contracts, in part because of a German commitment to reprocessing and the difficulties involved with reprocessing US-origin material. A government requirement that utilities provide a waste disposal plan has led to widespread reprocessing plans. By 1992, German utilities are expected to reprocess approximately 750 thousand pounds U_3O_8 equivalent annually.

To supplement long-term contracts, German utilities enter the spot market. Often spot sales have taken the form of non-arm's-length transactions between domestic utilities or units. Utilities have also bought on the open market, particularly when they have perceived prices to be artificially low. In general the West German utilities are strong financially and have the resources to purchase low-price material and stockpile it until needed.

The utilities also are willing to lend uranium from one unit to another as well as to non-German firms. The loan or sale of material occurs between units because each of the units of one utility may have different ownerships and thus their supply and demand situations are handled differently.

West German suppliers will provide 40 percent of German utilities' 1983 uranium deliveries. Those domestic suppliers receive most of their uranium as equity owners in two projects: Ranger in Australia and Key Lake in Canada. Table 5 lists West German participation in foreign uranium production projects.

Table 5

WEST GERMAN INTERESTS IN OPERATING URANIUM PRODUCTION FACILITIES

West German Company	Project	Percent Involved	Operating Entity
Saarberg Interplan	Ranger (Australia)	3.75	ERA
Urangesellschaft	Ranger (Australia)	4.04	ERA
	Arlit (Niger)	6.50	Somair
	Rossing (Namibia)	5.00	RTZ
RWE	Ranger (Australia)	6.31	ERA
Uranerz Canada Ltd.	Key Lake (Canada)	33.30	Key Lake Mining Corp.

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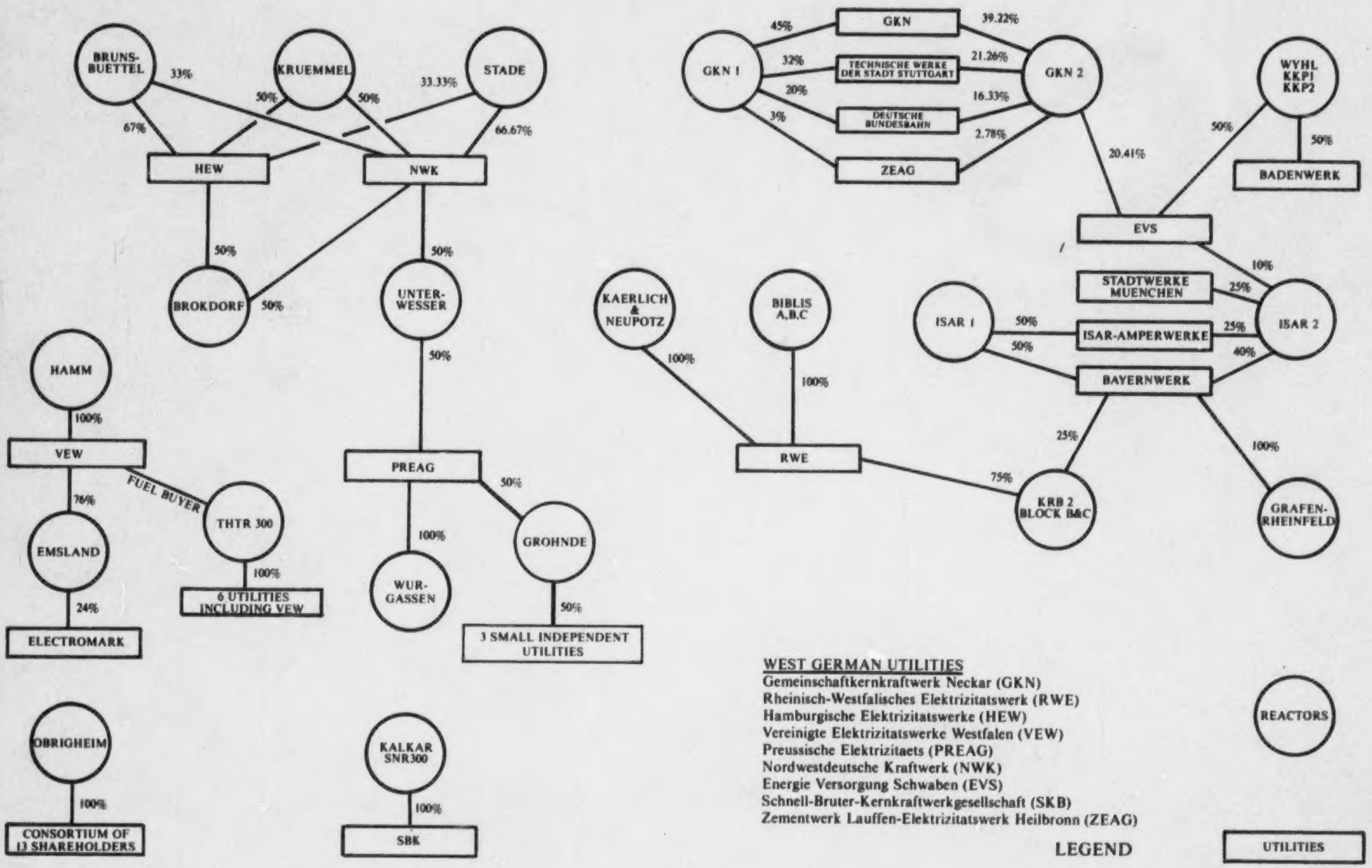
BRUNS-BUETTEL
KRUEMMEL
STADE
33%
67%
50%
50%
33.33%
66.67%
HEW
NWK
50%
50%
50%
BROKDORF
UNTER-WESSER
50%
PREAG
50%
100%
WUR-GASSEN
GROHNDE
50%
3 SMALL INDEPENDENT UTILITIES
HAMM
100%
VEW
FUEL BUYER
76%
EMSLAND
24%
ELECTROMARK
THTR 300
100%
6 UTILITIES INCLUDING VEW
OBRIGHEIM
100%
CONSORTIUM OF 13 SHAREHOLDERS
KALKAR SNR300
100%
SBK
GKN 1
45%
32%
20%
3%
GKN
TECHNISCHE WERKE DER STADT STUTTGART
DEUTSCHE BUNDESBAHN
ZEAG
39.22%
21.26%
16.33%
2.78%
GKN 2
20.41%
EVS
WYHL KKP1 KKP2
50%
50%
BADENWERK
10%
STADTWERKE MUENCHEN
25%
ISAR-AMPERWERKE
25%
BAYERNWERK
40%
ISAR 2
ISAR 1
50%
50%
KAERLICH & NEUPOTZ
100%
BIBLIS A,B,C
100%
RWE
75%
25%
KRB 2 BLOCK B&C
100%
GRAFEN-RHEINFELD
REACTORS
UTILITIES
LEGEND

WEST GERMAN UTILITIES
Gemeinschaftkernkraftwerk Neckar (GKN)
Rheinisch-Westfalisches Elektrizitatswerk (RWE)
Hamburgische Elektrizitatswerke (HEW)
Vereinigte Elektrizitatswerke Westfalen (VEW)
Preussische Elektrizitaets (PREAG)
Nordwestdeutsche Kraftwerk (NWK)
Energie Versorgung Schwaben (EVS)
Schnell-Bruter-Kernkraftwerkgesellschaft (SKB)
Zementwerk Lauffen-Elektrizitatswerk Heilbronn (ZEAG)

Figure 5
NUCLEAR REACTOR OWNERSHIP: WEST GERMANY

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Uranium Inventory

The West German government acquired approximately 7.4 million pounds U_3O_8 from the US in three rounds of "offset purchases," purchases made to offset the US dollar flow into West Germany associated with maintenance of US troops there. The actual amounts and forms of original purchases are listed in Table 6. The material, currently located at Urenco, is still in government hands and is used as a reserve similar to the Swedish reserve held by SKBF. West German utilities had approximately 27 million pounds U_3O_8 equivalent in inventory at the beginning of 1983. Adding the offset material to utilities' inventory results in a total national commercial uranium inventory of 34.4 million pounds U_3O_8 equivalent.

Table 6

WEST GERMAN OFFSET PURCHASES FROM THE US

Offset Number	Amount (millions of lbs. U_3O_8 equivalent)	(millions of SWUs)
1	3.56	1.1
2	0.94	0
3	2.86	0.9
TOTAL	7.36	2.0

Conversion and Enrichment

An indication of West German utilities' tendency towards diversification can be seen in their conversion and enrichment contracts. German nuclear utilities currently use Comurhex, BNFL, and Eldorado for conversion. Enrichment contracts for the 26 units listed in Table 4 include 12 with DOE, 6 with Urenco, and 5 with Techsnabexport, along with 2 additional Urenco contracts which will take effect after one DOE contract and one Techsnabexport contract expire. Table 7 lists the known US DOE enrichment contract commitments.

Nuclear Waste

Solving nuclear waste and spent fuel problems is crucial to the continuation of West Germany's nuclear power program. Utilities must present firm waste storage or disposal plans before operating permits are granted. By 1985, a generic decision will be made whether to develop domestic reprocessing or final storage facilities. Presently two intermediate storage sites are being developed, and one reprocessing plant should be operational by the mid-1990s.

The projection of close to 30,000 MWe nuclear capacity by the mid-1990s will result in an accumulation of approximately 28 million pounds of spent fuel. Under current plans, 9 million pounds will be reprocessed in France or the UK, capacity will be developed to store onsite 12 million pounds, 8 million pounds will be left at interim storage facilities, and 4 million pounds will be in reception storage at a German reprocessing plant.

Table 7

WEST GERMAN ENRICHMENT CONTRACTS WITH US DOE[1]
(thousands of SWUs)

Reactor	Utility	Contract Type	FY84	FY85	FY86	FY87	FY88	FY89
Brunsbuttel	HEW	3.5-yr Req	0	0	0	0	92	92
KKP-1	Badenwerk/EVS	3.5-yr Req	0	0	0	95	86	86
Obrigheim	KWO	3.5-yr Req	36	45	45	44	43	43
Stade	NWK	5-yr Req	37	83	86	86	86	86
THTR	HKG	5-yr Req	0	0	0	31	41	41
Wuergassen	PREAG	5-yr Req	78	0	0	0	0	0
Emsland	VEW	AFC	0	0	0	49	0	0
Grohnde	PREAG	AFC	0	134	145	145	145	145
Isar-1	Bayernwerk	AFC	66	65	0	0	0	0
KKP-1	Badenwerk/EVS	AFC	52	0	0	0	0	0
Neupotz	RWE	AFC	0	0	16	0	0	0
Unterwesser	NWK	AFC	93	0	164	164	164	165

[1] Published by DOE in September 1983.

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Summary

Comparing the total of West German utilities' supplies with Nuexco's estimate of uranium consumption (which is based in part on estimates of commercial operation dates that may vary with utility forecasts), a summary of West German utilities' uranium supply and demand situation is presented in Table 8.

Table 8

WEST GERMAN UTILITIES URANIUM INVENTORY BALANCE
(millions of pounds U_3O_8 equivalent)

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Beginning Inventory[1]	31.0	33.2	30.6	30.0	30.6	27.1	24.3	23.2	21.7	20.0
plus										
Annual Supply[2]	6.2	6.1	6.9	6.1	5.5	5.7	6.2	6.2	6.1	6.1
less										
Consumption[2]	4.0	8.7	7.5	5.5	9.0	8.5	7.3	7.7	7.8	7.8
equals										
Ending Inventory	33.2	30.6	30.0	30.6	27.1	24.3	23.2	21.7	20.0	18.3
RELATIVE INVENTORY (years)[3]	4.6	4.3	4.0	4.0	3.8	3.5	3.2	3.0	2.8	2.5

[1] Nuexco estimate.
[2] Nuexco tabulation.
[3] For each year, Relative Inventory equals the number of years of forward consumption which could be supplied by that year's Beginning Inventory.

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THE OLYMPIC DAM PROJECT

Introduction

The copper-uranium-gold occurrence known as Olympic Dam is one of the world's largest known mineral deposits. The deposit is located on Roxby Downs Station about 520 km northwest of Adelaide, South Australia (Figure 6). It was discovered in July 1975 by exploration crews of Western Mining Corporation (WMC). The first hole drilled to test a geologic concept conceived by WMC, based on regional geophysical anomalies, penetrated 38 meters of copper sulfide mineralization at a depth of 353 meters. Approximately 80 percent of the 450 holes drilled on the geophysical structure indicate mineral resources that total more than two billion tonnes. The potential is excellent to increase the resource base by a significant quantity as exploration continues in the general area of interest.

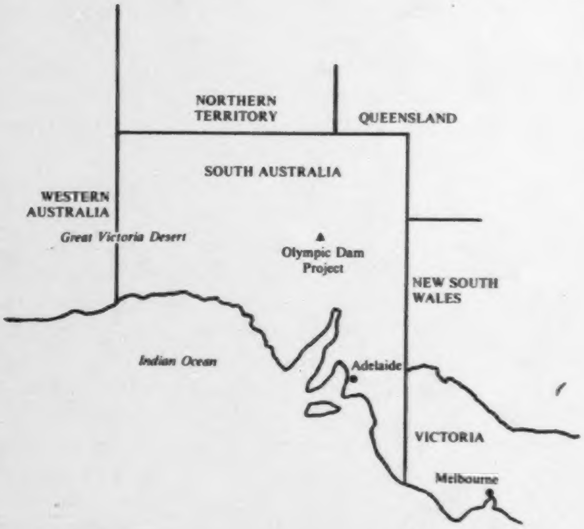

Figure 6

LOCATION OF OLYMPIC DAM PROJECT ROXBY DOWNS STATION, SOUTH AUSTRALIA

That Olympic Dam is one of the world's great ore deposits is readily apparent from a recent description published by WMC[1]. According to WMC, an estimate of resources indicates the huge deposit has an average mineral content of 1.6 percent copper, 0.06 percent uranium oxide, and 0.6 grams per tonne of gold. The deposit may contain more than 30 million tonnes copper, one million tonnes uranium oxide, one million kilograms of gold, plus at least seven million kilograms of silver.

Compared directly with other world-class ore deposits, Olympic Dam's copper resource is six times larger than the Mount Isa deposit; the uranium resource is more than twice the size of any other known uranium resource in the world; the gold resource is more than twice the size of known recoverable gold resources at Driefontein in South Africa; and silver resources are larger than any other known world resource with the exception of Mount Isa. A life of at least 30 years is presently planned for the project; however, if the deposit is mined at a rate of 150,000 tonnes copper annually, project life could exceed a century.

Ownership and Development Plans

WMC announced on July 27, 1979 that an agreement in principal had been reached to conduct further project evaluation under a joint venture arrangement. Roxby Mining Corporation Pty. Ltd., a wholly-owned subsidiary of Western Mining Corporation Holdings Ltd., will retain 51 percent interest in the project; BP Australia Ltd., and BP Petroleum Development Ltd., both subsidiaries of British Petroleum (BP), will earn a 49 percent interest in the project. The terms of the agreement require BP to provide $50 million for further exploration, metallurgical testing and other work directed toward the completion of a feasibility study for commercial development of Olympic Dam.

Among other requirements and provisions of the agreement, BP is to insure funds for the development of mining and processing facilities at a production rate of up to 150,000 tonnes copper annually (at that rate, uranium production could total about 3,000 tonnes U_3O_8 annually). WMC's share of development funds are to be secured by property assets and can be repaid from the project's cash flow. Project evaluation is continuing under the direction of the Olympic Dam Joint Venturers (ODJV). Designated operator of the project is Roxby Management Services Pty. Ltd. (RMS), a wholly-owned subsidiary company of Western Mining Corporation Holdings Ltd. RMS will be the operator for the life of the project.

The ODJV entered into an indenture agreement with the government of South Australia in June 1982. The agreement established site boundaries for the mine and processing plant and specified that special mining leases would be granted if applied for properly. In addition, the ODJV is obligated to invest at least $50 million on project evaluation, including completion of a feasibility study, between January 1, 1982 and December 31, 1984. The ODJV also is obligated to notify the state government before December 31, 1987 of any decision for further project development.

---

[1] The Olympic Dam Project, Information Release, Aug/Sept. 1983

Project expenditures by the ODJV exceeded $90 million by July 1983, and $60 million has been budgeted for expenditures through December 31, 1984. Expenditures to date include the cost of an environmental impact study published in October 1982 and a supplemental study published in April 1983. Both studies were submitted to the state and commonwealth governments; approval of the environmental evaluation was granted in June 1983.

Projections of capital costs for development befit the project's overall size. The ODJV has estimated that capital costs, expressed in December 1981 Australian dollars, will be $1.4 billion (development period considered is 8 to 10 years). The cost breakdown is:

1. Mine: $300 million;
2. Metallurgical plant: $700 million;
3. Infrastructure and town: $400 million.

The government of South Australia will contribute an additional $50 million towards the cost of a new townsite required as an integral part of the project. The town will be built to accommodate a population of 9,000, with long-range planning for accommodation of up to 30,000.

Development to Date

The project currently is in the early stages of development planning. The technical aspects of mine engineering are advanced because of actual mining experience in the orebody, and orebody delineation is continuing with exploration and grid drilling. The major steps leading to commercial development will be included in the final project feasibility study due for completion by December 31, 1984.

The ODJV commissioned the sinking of an exploration shaft in 1980, designated the Whenan shaft. It was completed to a depth of 500 meters in the third quarter of 1982 (see Figure 7). Over 1.5 kms of lateral drifts have been developed off the shaft to gain access to the orebody. Exploration by underground diamond drilling has effectively aided orebody delineation. More precisely, the drilling has detailed a large, high-grade ore block readily accessible from the shaft. The ore block consists of approximately 450 million tonnes averaging 2.5 percent copper and 0.08 percent U_3O_8. For actual development conventional underground mining methods probably will be used; the thicker ore zones will be stope mined with some cut-and-fill mining where appropriate, and the thinner ore zones will be mined by room-and-piller techniques (Figure 8).

A pilot plant for development of an extractive metallurgical process will be operable in the first quarter, 1984. The ore will be crushed and fine-ground in semi-autogenous and ball mills; the sulfides will be separated by conventional flotation; the concentrates will be further processed by roasting, leaching and/or smelting. Due to the complexity of the mineral suite, pressure leaching may be a required step for maximum recovery of the uranium. Otherwise, most of the uranium will follow the flotation tailings for acidic leaching and precipitation as U_3O_8. The final product will be magnesium uranate, containing at least 70 percent U_3O_8.

The future development of the Olympic Dam deposit has been a political issue almost from the time of discovery. A controversy developed on a national scale when the copper sulfides were discovered to contain uranium. On November 7, 1983, the Labor government approved a proposal to allow the project to proceed (see *Recent Developments,* this Report).

Ore Deposit

The mineral suite at Olympic Dam includes copper, uranium, gold, silver and rare earths. Mineralization occurs in the Olympic Dam and Greenfield Formations of Proterozoic age (Precambrian). The mineralized host sequence consists of unmetamorphosed sedimentary breccias containing a variety of fine to coarse-grained rock-types, usually rich in granitic and arkosic material. The entire sequence is considered to be the upper part (over 1 km thick) of Gawler domain rocks deposited and preserved in a structural trough referred to as the Olympic Dam graben. The structure is almost 8 km in length and has a maximum width of over 4 km.

Two types of copper sulfide mineralization occur in economic concentrations in portions of the Olympic Dam and Greenfield Formations confined to the graben. Mineralization is known to occur at a depth from the surface of 343 meters to a drilled depth of 1,150 meters. The greatest concentration of mineralization is usually associated with areas of intense hematite and chlorite alteration in the four upper members of the Olympic Dam Formation; serite and silica alteration are more common in the uppermost member, and in the lower member of the Greenfield Formation. Commercial-grade sulfide

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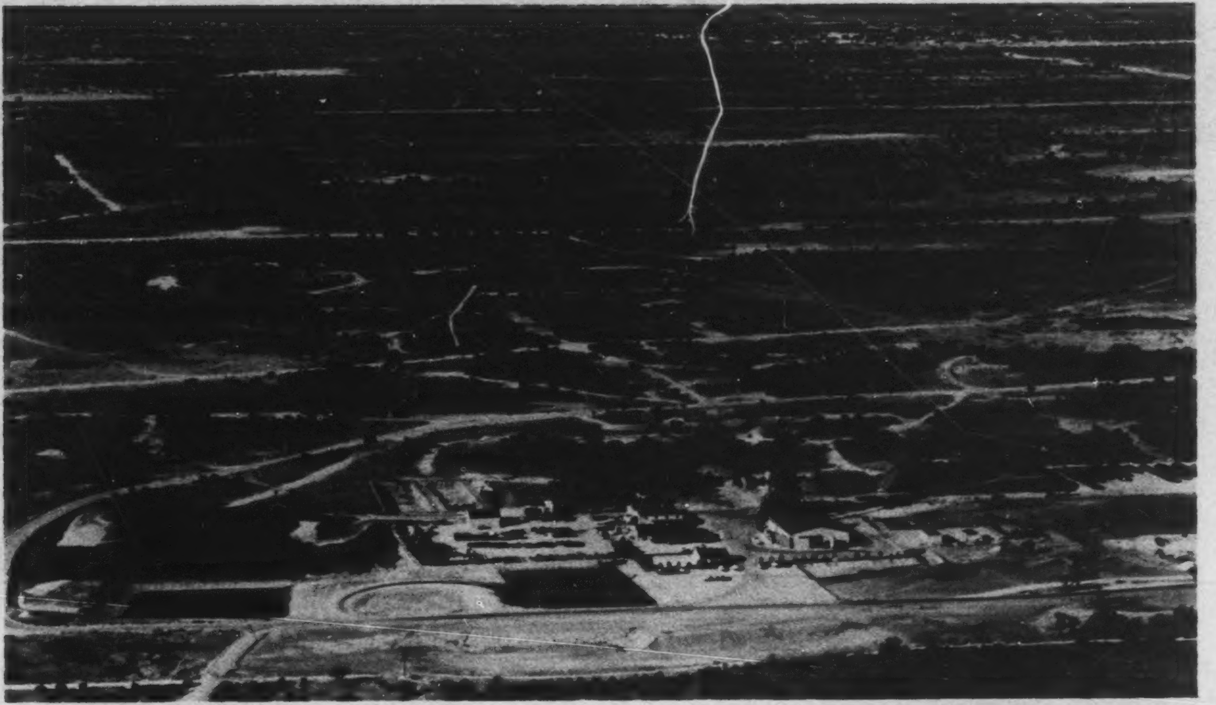

Figure 7. Aerial photo of the Whenan shaft site. Headframe and ore storage area on the right, waste pile on the left. Roads outline a portion of the grid system utilized for exploration drilling.

Figure 8. Underground mining on the 420 meter level, Whenan shaft.

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RAW MATERIALS

mineralization is thus far confined to the area influenced by the graben. (Away from Olympic Dam, mineralization has been discovered at Acropolis, 25 km to the southwest, and at Wirrda Well, 20 km to the southeast; however, it is low-grade and considerably more exploration work is required to determine the economic potential in each case. Neither area is included in the Olympic Dam project.)

A brief geologic description of the mineral-bearing formations is summarized in Table 9.

Table 9

MINERALIZED FORMATIONS AT OLYMPIC DAM[1]

Geologic Age—Middle Proterozoic			**Greenfield Formation**	
			Volcanic Member (250 m thick)	Volcanic breccias and conglomerates
			Hematite Breccia Member (500 m thick)	Hematite-rich breccias and siltstones
	Mineralized Sequence	Transgressive Type	Lower Silicified Member (275 m)	Hematite and silicifed breccias, *chalcocite* and *bornite minerals*
			Olympic Dam Formation	
			Upper Granite Breccia Member (100 m thick)	Hematite-rich granite breccia, *chalcocite* and *bornite minerals*
			Brooks Member (300 m thick)	Mixed rock breccias, brown and black hematite matrix, *chalcopyrite, bornite and chalcocite minerals*
		Strata-bound Type	Whenan Member (350 m thick)	Mixed rock breccias, black and red hematite matrix, bedded units throughout, *bornite* and *chalcopyrite minerals*
			Black Hematite Member (150 m thick)	Mixed rock breccias, black hematite matrix, *chalcopyrite mineral*
			Lower Granite BrecciaMember (800 m thick)	Granite and mixed rock breccias, chlorite alteration

[1] Adapted from D.E. Roberts and G.R.T. Hudson, RMS, Economic Geology, August 1983.

The most important mineralization is found in strata-bound accumulations of bornite (Cu_5FeS_4), chalcopyrite ($CuFeS_2$) and chalcocite (Cu_2S) in the four upper hematite-rich (Fe_2O_3) members of the Olympic Dam Formation (see Table 9). The mineralization is uniformly disseminated throughout the matrix of the formations, making up 5 to 20 percent of the rock throughout a maximum thickness of at least 350 meters. The mineralization occurs as distinct grains in the matrix of host breccias, varying greatly in size from submicron to several centimeters. The largest particles are generally chalcopyrite and pyrite (FeS_2) intergrown with hematite in a quartz and fluorite-rich matrix. The mineralization accompanied the depositional process of the breccias. It is therefore considered to be syngenetic, being related to geothermal conditions associated with regional volcanism.

There is a distinct pattern to vertical zoning of mineralization. The sulfides tend to be sulfur-rich and copper-poor in the Black Hematite Member of the Olympic Dam Formation. Toward the top of the overlying Whenan Member and into the Brooks Member, the sulfides become copper-rich and sulfur-poor. Throughout the sequence, evidence of advanced weathering and mineral enrichment is rare; however, oxidation has been noted through the full thickness of the mineral sequence. Lateral zoning of the ore minerals has not been observed over its known length of approximately 7.5 km and maximum width of at least 4 km.

The second important occurrence of sulfide mineralization is the transgressive type consisting primarily of chalcocite and bornite sulfides confined to the Brooks Member and Upper Granite Member of the Olympic Dam Formation and the Lower Silicified Member of the Greenfield Formation. The transgressive mineralization is younger and generally overlies the strata-bound ore zone. The mineralization is confined to the central portion of the graben, extending northwest-southeast over a trend length of 7 km and a maximum width of over 2 km across two paralleling ore trends.

The minerals occur as highly disseminated grains and sulfide intergrowths, and as vein and cavity-filling material in irregular occurring lenses in a hematite-rich environment. The sulfide intergrowths vary greatly in size, but may be up to 10 centimeters across. Zoning or enrichment of mineralization has not occurred in the transgressive deposit. The ore minerals are epigenetic, having been introduced after deposition of the breccias by mineral-rich solutions migrating through the upper formations during the final stages of the first mineralizing event. Mineral concentration is limited to structurally favorable conditions within the graben. The ore deposit is age dated at 1,580 million years.

Uranium occurs disseminated throughout both types of sulfide mineralization. It is extremely fine-grained, varying from submicron to 3 millimeters in size. The

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principal ore mineral is uraninite (UO_2). The mineral coffinite $[U(SiO_4)]$ occurs in close association, primarily in the more altered zones, as coatings on fractures and veins, and as discrete grains of matrix material. Brannerite $[U,Ca,Th(Ti,Fe)_2O_6]$ is the third uranium mineral present, occurring almost exclusively in veins within the Brooks Member of the Olympic Dam Formation. The brannerite grains are always completely surrounded by a halo of rutile (TiO_2), forming an unusual mineral combination. Uranium deposition occurred during both phases of sulfide mineralization.

Free gold is scattered throughout both sulfide zones. The concentration is higher in the transgressive ore zone. It also occurs with hematite and is disseminated in the matrix. Silver is closely associated with gold; however, the percentage content is higher in the bornite-rich sulfide zones. It occurs as native silver and silver tellurides.

The rare earth minerals bastenite $[(Ce, La)CO_3(F,OH)]$ and florencite $[CeAl_3(PO_4)_2(OH)_6]$ average 0.50 percent combined rare earths. They occur primarily in association with the sulfides, but commonly with hematite and sericite alteration. The recovery of rare earths is only a minor consideration in project planning due to the low-grade nature of the occurrence.

Geology

The Olympic Dam mineral district is located in the Stuart shelf region. It is of the Australian Shield, which forms the surface rocks over large areas of South Australia. Generally, the shield areas are composed of Precambrian rocks which have been relatively stable throughout long periods of geologic time. Tectonic influence on the rock formations was for the most part limited to gentle folding and down-warping, creating broad geosynclines.

The oldest rocks in the region are included in the lower Gawler domain. They form the basement for a large part of the shield area. The rocks are Archean in age and consist of reworked gneiss, schist and intrusive rocks. Later volcanics and associated granites, age dated at about 1,500 m.y., intruded the older metamorphic sequence, as well as younger sandstones, conglomerates and volcaniclastic sediments.

Rock formations of the Stuart shelf region consist of Adelaidean sediments of late Proterozoic to Cambrian age. The sedimentary sequence is about 350 meters thick and overlies upper Gawler domain rocks—the host for the Olympic Dam deposit. The Stuart shelf is isolated from the Adelaide geosyncline to the east by a major north-south fault system referred to as the Torrens hinge zone. Geologic structure east of the hinge zone is characterized by a broad system of complex folding and faulting. This is in contrast to the more gentle structural features throughout the western part of the Stuart shelf region.

The Adelaidean sediments covering the Stuart shelf do not reflect the tectonic complexities that exist in the basement rock, primarily because of a major nonconformity that seperates the two formations. The Olympic Dam graben was revealed by drilling. The sedimentary breccias within the graben show structural displacement of more than 600 meters while paralleling faults outside the graben show displacement of up to 1200 meters.

The mineralized breccias within the graben were formed during a period of abrupt change in depositional patterns, weathering and erosion. The activity was associated with extreme tectonic activity related to development of the graben during the Kimban orogeny age dated 1,800 to 1,580 m.y. The Stuart shelf region became stable following the Kimban orogeny thereby preserving the ore deposit in the graben. There is geophysical evidence that other potentially important structures exist on the Stuart shelf, as verified by exploration successes at Acropolis and Wirrda Well. The Stuart shelf region has the geologic potential of becoming one of the largest and most prolific mineral belts of the world.

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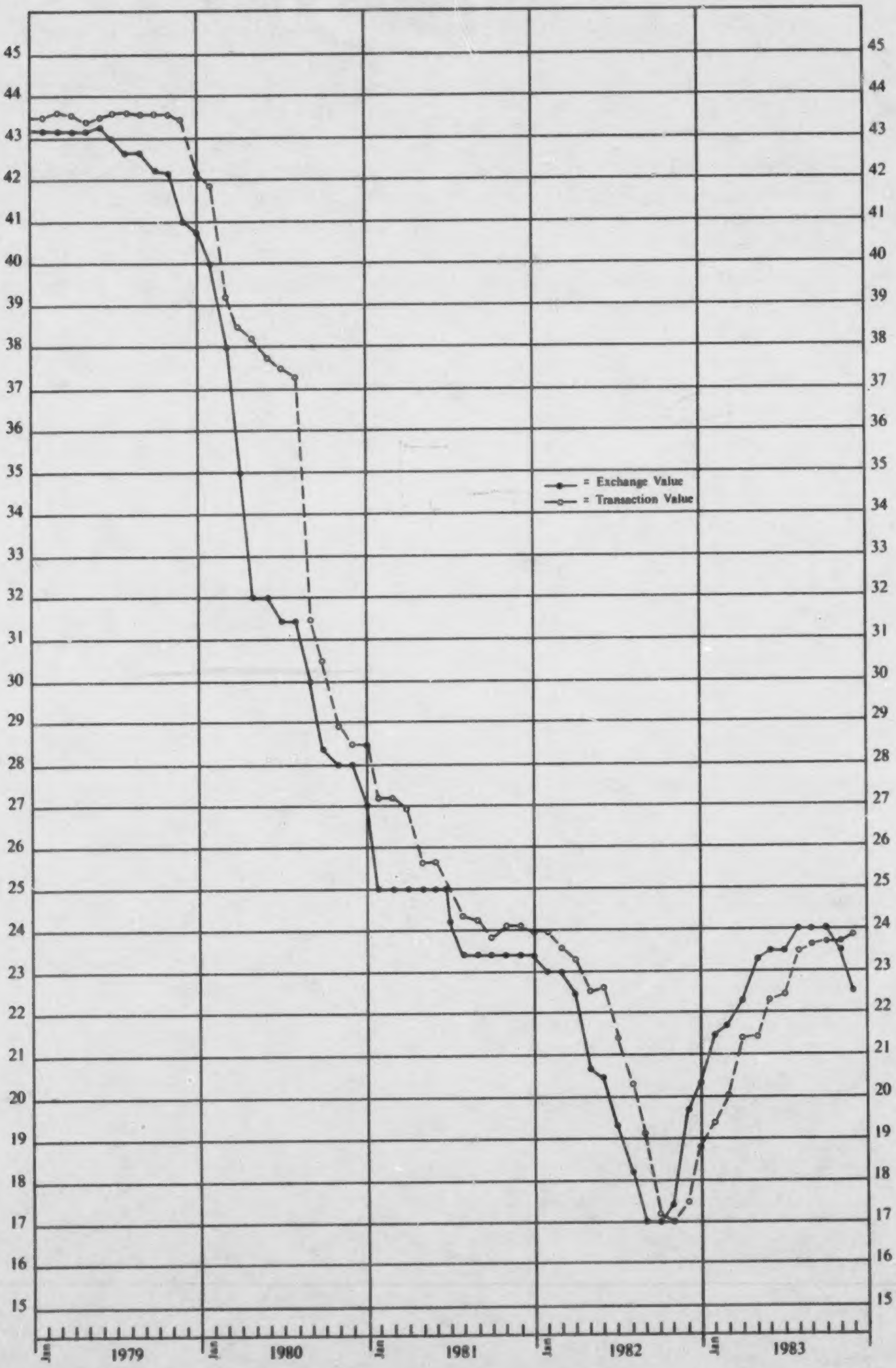
HISTORICAL MARKET DATA

EXCHANGE AND TRANSACTION VALUES SINCE JANUARY 1979

Determined as of the last day of the month indicated



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HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	**22.50**	

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	**23.85**	

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	**0.60**	

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GOVERNMENT STATISTICS

AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage Earners, Weekly Rates[2] (1976=100)
1972 Avg.	105.6	71.26
1973 Avg.	124.4	78.96
1974 Avg.	141.9	108.07
1975 Avg.	150.4	132.55
1976 Avg.	168.4	160.93
1977 Avg.	192.0	179.03
1978 Avg.[3] [4]	198.5	190.04
1979 Avg.	248.8	127.9R
1980 Avg.	321.8	140.8R
1981 Avg.	355.3	154.1R
1982 Avg.	368.6R	174.9R
Aug 1982	372.6R	178.2
Sep 1982	375.3R	178.4
Oct 1982	378.5R	178.4
Nov 1982	375.9R	178.5
Dec 1982	374.9R	179.5
Jan 1983	385.7R	179.6
Feb 1983	387.5R	179.5
Mar 1983	397.4R	179.4
Apr 1983	407.3R	179.7
May 1983	414.8R	179.8
Jun 1983	415.6R	179.9
Jul 1983	408.4P	179.5
Aug 1983	402.9P	179.5
Sep 1983	—	179.4P

P = Preliminary R = Revised since last month

[1] Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0).

[2] Australian Bureau of Statistics, Canberra: "Award Rates of Pay Indexes, Australia" (Catalogue No. 6312.0). Figures for the latest fourteen months shown are subject to revision.

[3] Monthly data for 1970-78 appear on pages 4.7 and 4.8 of Report 138.

[4] Annual averages prior to 1979 reflect index base no longer in use.

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AUSTRALIA: MONTHLY FIGURES 1979-1982

		Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Adult Males in Mining Wage Earners, Weekly Rates[2] (1976=100)
Jan	1979	246.3	123.8
Feb	1979	253.0	123.9
Mar	1979	264.0	124.5
Apr	1979	274.0	124.9
May	1979	288.5	125.5
Jun	1979	294.9	129.5
Jul	1979	298.2	129.7
Aug	1979	293.2	130.4
Sep	1979	302.4	130.8
Oct	1979	309.4	130.6
Nov	1979	310.4	130.3
Dec	1979	319.4	131.1
Jan	1980	340.1	138.6
Feb	1980	345.6	138.5
Mar	1980	340.3	138.5
Apr	1980	328.4	138.6
May	1980	335.6	138.6
Jun	1980	338.8	138.3
Jul	1980	347.8	143.1
Aug	1980	352.0	142.5
Sep	1980	350.3	142.5
Oct	1980	348.2	143.0
Nov	1980	350.4	143.2
Dec	1980	351.7	143.9
Jan	1981	357.8	149.3
Feb	1981	356.6	149.2
Mar	1981	355.2	148.9
Apr	1981	354.6	148.7
May	1981	353.4	154.0
Jun	1981	360.4	154.5
Jul	1981	357.8	154.6
Aug	1981	360.9	154.8
Sep	1981	358.4	154.8
Oct	1981	352.5	155.3
Nov	1981	351.3	157.3
Dec	1981	349.9	167.3
Jan	1982	354.9	169.3
Feb	1982	356.7	171.1
Mar	1982	360.3	171.4
Apr	1982	368.4	171.4
May	1982	368.2	171.9
Jun	1982	367.9	173.2
Jul	1982	370.1	177.2
Aug	1982	372.6	178.2
Sep	1982	375.3	178.4
Oct	1982	378.5	178.4
Nov	1982	375.9	178.5
Dec	1982	374.9	179.5

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[1] Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0).

[2] Australian Bureau of Statistics, Canberra: "Award Rates of Pay Indexes, Australia" (Catalogue No. 6312.0).

GOVERNMENT STATISTICS

CANADA

	Industry Selling Price Index: Manufacturing[1] (1971=100)	Wage-earner Data: Average Hourly Earnings (C$)[2] [3]				
		Metal Mining, including Milling[4] (SIC 050-099)	Primary Metal Industries Non-ferrous[5]			Chemicals and Chemical Products[4] (SIC 372-379)
			(SIC 296)	(SIC 296-298)	(SIC 298)	
1979 Avg.[7]	217.9	9.66	—	7.35	—	7.67
1980 Avg.	247.2	10.80	—	8.05	—	8.50
1981 Avg.	288.7	12.23	—	9.03	—	9.53
1982 Avg.	288.8	13.92	—	9.98	—	10.63
Aug 1982	290.3	14.23	—	10.03	—	10.80
Sep 1982	292.4	14.01	—	10.18	—	10.73
Oct 1982	292.1	13.89	—	10.18	—	10.86
Nov 1982	291.3	14.28	—	10.43	—	10.90
Dec 1982	292.3	14.32	—	10.55	—	11.06
Jan 1983	292.7	14.35	—	10.72	—	11.06
Feb 1983	293.5	14.28	—	10.74	—	11.06
Mar 1983	295.2	14.48	—	10.93	—	11.21
Apr 1983	297.1	14.13	11.57	—	10.10	11.02
May 1983	298.5	14.10	11.39	—	9.82	10.97
Jun 1983	299.3R	14.07	11.33	—	9.84	11.05
Jul 1983	300.4R	13.93	11.70	—	9.83	11.04
Aug 1983	301.2R	13.89R	11.82R	—	10.08	11.19R
Sep 1983	301.0	14.15P	11.96P	—	10.28P	11.19P
Oct 1983	301.7P	—	—	—	—	—

P = Preliminary R = Revised since last month

[1] Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (Catalogue 62-011). Indexes for the most recent six months shown are subject to revision.

[2] Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours" (Catalogue 72-002).

[3] Beginning with the April 1983 figure, Wage Earner Data are based on a census of all companies employing 200 or more wage earners, *plus* a random survey of companies employing fewer than 200 wage earners. Prior to April 1983 only companies employing fewer than 200 wage earners are included in the Wage Earner Data.

[4] The wage earner series in Nuexco reports prior to March 1983 was "Metals" (SIC 050-059).

[5] Beginning with the April 1983 figure, Primary Metal Industries, non-ferrous is split into SIC 296 and SIC 298.

[6] Chemical and Chemical Products prior to April 1983 was SIC 370-379. The new series is from a new survey which includes all companies and is based on a 1970 classification. The old survey only included companies of 20 employees or more.

[7] Monthly ISPI for 1977 and 1978 appear on page 4.10 of Report 138, and monthly wage-earner data for 1973-78 appear on page 4.11 of Report 138.

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CANADA: MONTHLY FIGURES 1979-1982

	Industry Selling Price Index: Manufacturing (1971 = 100)	Metal Mining, including Milling (SIC 050-099)	Wage-earner Data: Average Hourly Earnings (C$)[2] Primary Metal Industries Non-ferrous (SIC 296-298)	Chemicals and Chemical Products (SIC 370-379)
Jan 1979	204.8	9.30	7.14	7.29
Feb 1979	208.5	9.40	7.18	7.36
Mar 1979	210.4	9.48	7.20	7.51
Apr 1979	212.8	9.60	7.26	7.63
May 1979	214.5	9.56	7.28	7.61
Jun 1979	216.0	9.51	7.27	7.66
Jul 1979	218.3	9.45	7.34	7.73
Aug 1979	220.0	9.60	7.38	7.77
Sep 1979	223.4	9.82	7.50	7.81
Oct 1979	227.4	10.03	7.54	7.88
Nov 1979	228.1	10.11	7.61	7.91
Dec 1979	230.4	10.05	7.51	7.89
Jan 1980	239.0	10.26	7.57	7.99
Feb 1980	240.8	10.38	7.69	8.08
Mar 1980	239.5	10.59	7.83	8.26
Apr 1980	241.1	10.54	7.94	8.36
May 1980	242.4	10.64	8.01	8.44
Jun 1980	243.7	10.67	8.07	8.46
Jul 1980	246.3	10.69	8.11	8.55
Aug 1980	249.4	10.74	8.14	8.65
Sep 1980	252.0	11.00	8.24	8.71
Oct 1980	256.0	11.29	8.28	8.82
Nov 1980	257.8	11.42	8.38	8.77
Dec 1980	258.4	11.43	8.32	8.92
Jan 1981	263.3	11.58	8.51	8.90
Feb 1981	263.7	11.73	8.59	9.00
Mar 1981	265.5	11.76	8.63	9.17
Apr 1981	267.9	11.93	8.76	9.33
May 1981	270.0	11.99	8.90	9.49
Jun 1981	272.3	12.03	9.16	9.57
Jul 1981	274.3	12.07	9.20	9.62
Aug 1981	276.2	12.19	9.15	9.63
Sep 1981	276.9	12.63	9.22	9.77
Oct 1981	279.3	12.82	9.35	9.91
Nov 1981	278.8	13.01	9.45	9.89
Dec 1981	280.0	12.96	9.42	10.03
Jan 1982	281.9	13.49	9.53	10.11
Feb 1982	283.5	13.61	9.60	10.19
Mar 1982	284.8	13.74	9.62	10.35
Apr 1982	287.7	13.81	9.79	10.48
May 1982	288.8	13.86	9.88	10.62
Jun 1982	289.7	13.83	9.92	10.69
Jul 1982	290.3	14.02	10.05	10.73
Aug 1982	290.3	14.23	10.03	10.80
Sep 1982	292.4	14.01	10.18	10.73
Oct 1982	292.1	13.89	10.18	10.86
Nov 1982	291.3	14.28	10.43	10.90
Dec 1982	292.3	14.32	10.55	11.06

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[1] Statistics Canada, [illegible] Division, Ottawa: "Industry Price Indexes" (Catalogue 62-011).

[2] Statistics Canada, [illegible] Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours" (Catalogue 72-002).

GOVERNMENT STATISTICS

REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100)[3]	Producer Price Index All Groups[4] (1975=100)	Total Employment in Mining and Quarrying (Code 35)[5]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[5]
1972 Avg.	8.79	113.3	63.9	623,067	443,933
1973 Avg.	10.51	124.1	72.3	684,743	572,133
1974 Avg.	13.18	138.5	85.3	674,140	761,596
1975 Avg.	16.71	157.2	100.0	639,473	1,003,617
1976 Avg.	19.30	174.7	115.1	671,240	1,212,983
1977 Avg.	23.87	194.4	130.0	712,006	1,420,670
1978 Avg.	27.14	137.2	142.7	664,571	1,537,169
1979 Avg.[6]	30.18	155.3	164.5	692,209	1,830,632
1980 Avg.[7]	35.53	176.7	192.1	714,379	2,279,615
1981 Avg.	41.89	206.5	218.3	728,506	2,820,505
1982 Avg.	47.25	233.5	248.7	707,552	3,246,071
May 1982	—	230.3	244.8	715,162	258,770
Jun 1982	45.77	232.1	246.7	707,552	261,361
Jul 1982	—	234.1	249.4	702,141	283,248
Aug 1982	—	236.8	253.4	705,562	276,730
Sep 1982	48.04	241.0	255.0	704,344	282,782
Oct 1982	—	243.9	260.1	701,316	285,328
Nov 1982	—	245.4	262.5	707,966	287,699
Dec 1982	49.62	246.2	263.0	683,982	288,019
Jan 1983	—	249.0	264.9	688,030	289,075
Feb 1983	—	253.1	267.4	697,089	281,413
Mar 1983	50.35	255.9	269.1	695,976	290,586
Apr 1983	—	257.8	270.9	697,158	286,708
May 1983	—	259.7	274.1	701,712	295,701
Jun 1983	50.51	260.8	273.1	706,933	300,177
Jul 1983	—	262.5	273.7	704,202	314,566
Aug 1983	—	265.6	278.9	698,984	311,789
Sep 1983	52.92	267.3	279.4	—	—
Oct 1983	—	270.0	—	—	—

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[1] Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly. The tonnage-weight index of average working costs per metric ton of gold ore milled for 1983 follows. (Base: March quarter 1982 = 100). See page 16 of Report 178 for the description and calculation of index, and page 24 of Report 178 for figures for 1982.

1983:	January-March	111.2
	April-June	111.9

[2] Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."

[3] For annual averages prior to 1978, April 1970 = 100.

[4] Previously known as the WHOLESALE PRICE INDEX, now the PRODUCER PRICE INDEX. The computation remains the same.

[5] Bulletin of Statistics, Department of Statistics, Pretoria.

[6] Historical data for the Average Declared Working Costs and Consumer Price Index 1970-1979 appear on page 4.9 of Report 140.

[7] Monthly data for Codes 35 and 40, 1977-1980, appear on page 28 of Report 157.

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REPUBLIC OF SOUTH AFRICA: MONTHLY FIGURES 1979-1982

		Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975=100)	Producer Price Index All Groups (1975=100)	Total Employment in Mining and Quarrying (Code 35)[3]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[3]
Jan	1979	—	145.3	150.6	664,394	137,630
Feb	1979	—	146.1	152.1	680,054	136,252
Mar	1979	28.60	148.6	153.9	689,770	139,717
Apr	1979	—	149.9	155.3	682,505	143,812
May	1979	—	150.6	159.6	689,749	146,732
Jun	1979	29.44	152.4	163.1	692,209	152,862
Jul	1979	—	157.9	168.3	699,567	161,450
Aug	1979	—	160.2	171.4	692,377	159,514
Sep	1979	30.71	162.1	172.7	686,248	158,804
Oct	1979	—	162.9	174.5	692,859	162,721
Nov	1979	—	163.4	175.8	699,158	165,956
Dec	1979	31.89	164.0	176.8	697,741	165,182
Jan	1980	—	165.4	178.3	699,112	171,548
Feb	1980	—	167.0	180.5	705,758	165,790
Mar	1980	33.65	168.0	181.7	708,456	171,573
Apr	1980	—	170.0	184.2	710,652	169,415
May	1980	—	171.9	186.6	717,171	179,128
Jun	1980	34.48	174.6	189.0	714,379	183,739
Jul	1980	—	177.2	192.7	715,460	202,403
Aug	1980	—	179.2	196.8	716,486	206,514
Sep	1980	36.19	182.8	199.8	710,889	204,731
Oct	1980	—	186.3	203.1	720,246	204,602
Nov	1980	—	187.8	205.6	716,797	208,345
Dec	1980	37.69	189.9	206.5	705,087	211,829
Jan	1981	—	191.0	207.2	729,575	219,969
Feb	1981	—	193.8	209.8	725,647	210,275
Mar	1981	39.26	195.2	209.9	705,010	210,151
Apr	1981	—	196.4	211.6	719,674	217,124
May	1981	—	197.7	213.2	726,869	219,880
Jun	1981	40.41	200.0	215.3	728,506	237,049
Jul	1981	—	204.6	218.4	735,839	249,080
Aug	1981	—	208.0	222.6	722,684	245,817
Sep	1981	43.28	211.3	224.6	724,604	251,502
Oct	1981	—	213.4	227.0	717,918	248,159
Nov	1981	—	214.8	229.4	720,255	253,844
Dec	1981	44.52	216.3	230.4	709,612	257,655
Jan	1982	—	217.6	233.1	700,375	257,173
Feb	1982	—	210.2	236.8	705,992	250,190
Mar	1982	45.49	225.2	237.4	727,700	262,210
Apr	1982	—	228.9	241.9	707,502	252,562
May	1982	—	230.3	244.8	715,162	258,770
Jun	1982	45.77	232.1	246.7	707,552	261,361
Jul	1982	—	234.1	249.4	702,141	283,248
Aug	1982	—	236.8	253.4	705,562	276,730
Sep	1982	48.04	241.0	255.0	704,344	282,782
Oct	1982	—	243.9	260.1	701,316	285,328
Nov	1982	—	245.4	262.5	707,966	287,698
Dec	1982	49.61	246.2	263.0	683,982	288,019

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[1] Chamber of Mines of South Africa, Johannesburg: "Analysis of Working Results," published quarterly.

[2] Republic of South Africa Department of Statistics, Pretoria, "Government Gazette": Consumer Price Index for Urban Areas.

[3] Bulletin of Statistics, Department of Statistics, Pretoria.

GOVERNMENT STATISTICS

UNITED STATES

	Producer Price Index[1]		Consumer Price Index[2]	GNP Implicit Price Deflator[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
	Industrial Commodities (1967=100)	All Commodities (1967=100)	(1967=100)	(1972=100)	Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1972 Avg.	117.9	119.1	125.3	100.00	4.56	4.59	4.26	3.71
1973 Avg.	125.9	134.7	133.1	105.75	4.84	4.98	4.51	3.91
1974 Avg.	153.8	160.1	147.7	115.08	5.44	5.63	4.88	4.21
1975 Avg.	171.5	174.9	161.2	125.79	6.13	6.24	5.39	4.64
1976 Avg.	182.4	183.0	170.5	132.34	6.76	6.87	5.91	4.96
1977 Avg.	195.1	194.2	181.5	140.05	7.28	7.67	6.43	5.39
1978 Avg.[5]	209.4	209.3	195.4	150.42	8.23	8.56	7.02	5.82
1979 Avg.	236.5	235.6	217.4	163.42	9.27	9.50	7.60	6.32
1980 Avg.	274.8	268.8	246.8	178.64	10.26	10.63	8.30	6.94
1981 Avg.	304.1	293.4	272.4	195.51	11.55	11.98	9.12	7.62
1982 Avg.	312.3	299.3	289.1	207.15	12.33	12.94	9.96	8.21
Oct 1982	314.3	299.8	294.1	—	12.51	13.26	10.22	8.41
Nov 1982	315.0	300.3	293.6	—	12.53	13.22	10.26	8.45
Dec 1982	315.2	300.7	292.4	210.00	12.53	13.05	10.32	8.51
Jan 1983	313.9	299.9	293.1	—	12.63	13.33	10.34	8.53
Feb 1983	313.9	300.9	293.2	—	12.66	13.29	10.41	8.56
Mar 1983	313.5	300.6	293.4	212.83	12.48	13.35	10.39	8.60
Apr 1983	312.4	300.6	295.5	—	12.67	13.34	10.43	8.60
May 1983	313.6	301.5	297.1	—	12.55	13.62	10.50	8.60
Jun 1983	315.3R	302.4R	298.1	214.55	12.66	13.38	10.52	8.63
Jul 1983	316.6	303.2	299.3	—	12.68	13.56	10.58	8.69
Aug 1983	317.5	304.9	300.3	—	12.63	13.46R	10.61R	8.64
Sep 1983	317.2	305.3	301.8	216.29R	12.71	13.47	10.69R	8.75R
Oct 1983	318.7P	306.3P	302.6P	—	12.77P	13.57P	10.78P	8.73P

P = Preliminary R = Revised since last month

[1] US Bureau of Labor Statistics, Washington, D.C.: "Producer Prices and Price Indexes," (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

[2] US Bureau of Labor Statistics, Washington, D.C.: Consumer Price Index for All Urban Consumers, US City Average, All Items.

[3] US Department of Commerce, Washington, D.C.: Bureau of Economic Analysis, National Income and Wealth Division: "Survey of Current Business." The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

[4] US Bureau of Labor Statistics, Washington, D.C.: "Employment and Earnings." 2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for 1977-1978 are adjusted to the March 1979 benchmark. Data for January 1979 and beyond are adjusted to the March 1980 benchmark.

[5] Monthly data 1970-1978 for Producer Price Index-Industrial Commodities, Consumer Price Index, and Employment and Earnings SIC codes 10, 333, and 28, and quarterly data for GNP Implicit Price Deflator appear on pages 4.6-4.8 of Report 139.
Monthly data 1977-1978 for Employment and Earnings SIC Codes 10, 333, and 28 appear on page 33 of Report 147.
Monthly data 1970-1978 for Employment and Earnings SIC Code 36 appear on page 23 of Report 154.
Monthly data 1977-1980 for Producer Price Index-All Commodities, appear on page 21 of Nuexco Report 158.

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UNITED STATES: MONTHLY FIGURES 1979-1982

	Producer Price Index[1] Industrial Commodities (1967=100)	Producer Price Index[1] All Commodities (1967=100)	Consumer Price Index[2] (1967=100)	GNP Implicit Price Deflator[3] (1972=100)	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4] Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electronic and Electronic Equipment (SIC 36)
Jan 1979	220.0	220.8	204.7	—	8.71	9.00	7.33	6.12
Feb 1979	222.5	224.1	207.1	—	8.81	9.01	7.33	6.14
Mar 1979	225.4	226.7	209.1	158.60	8.85	9.11	7.37	6.17
Apr 1979	229.0	230.0	211.5	—	9.03	9.49	7.52	6.12
May 1979	231.6	232.0	214.1	—	9.06	9.14	7.48	6.22
Jun 1979	234.0	233.5	216.6	161.85	9.09	9.44	7.54	6.26
Jul 1979	237.5	236.9	218.9	—	9.33	9.57	7.61	6.28
Aug 1979	240.6	238.3	221.1	—	9.39	9.70	7.66	6.36
Sep 1979	244.2	242.0	223.4	165.12	9.63	9.79	7.74	6.46
Oct 1979	249.0	245.6	225.4	—	9.67	9.87	7.83	6.48
Nov 1979	250.6	247.2	227.5	—	9.79	9.86	7.89	6.51
Dec 1979	253.1	249.7	229.9	168.05	9.81	9.92	7.93	6.63
Jan 1980	260.6	254.9	233.2	—	9.92	10.06	7.98	6.66
Feb 1980	265.9	260.2	236.4	—	9.93	10.02	8.01	6.70
Mar 1980	268.6	261.9	239.8	171.94	9.91	10.24	8.06	6.76
Apr 1980	271.3	262.8	242.5	—	10.01	10.31	8.13	6.78
May 1980	271.9	264.2	244.9	—	10.19	10.37	8.18	6.76
Jun 1980	273.5	265.6	247.6	176.46	10.13	10.70	8.25	6.85
Jul 1980	276.2	270.4	247.8	—	10.24	10.84	8.37	6.94
Aug 1980	278.2	273.8	249.4	—	10.38	10.80	8.40	6.99
Sep 1980	278.8	274.6	251.7	180.24	10.54	10.95	8.47	7.11
Oct 1980	282.0	277.8	253.9	—	10.58	11.01	8.53	7.16
Nov 1980	283.4	279.1	256.2	—	10.72	11.08	8.60	7.25
Dec 1980	286.6	280.8	258.4	185.13	10.83	11.33	8.69	7.35
Jan 1981	291.5	284.8	260.5	—	10.90	11.32	8.75	7.37
Feb 1981	295.7	287.6	263.2	—	11.13	11.36	8.80	7.40
Mar 1981	299.6	290.3	265.1	189.83	11.11	11.51	8.85	7.44
Apr 1981	303.5	293.4	266.8	—	11.28	11.64	8.95	7.47
May 1981	304.7	294.1	269.0	—	11.24	11.70	8.99	7.51
Jun 1981	305.1	294.8	271.3	192.56	11.29	11.90	9.06	7.57
Jul 1981	306.2	296.2	274.4	—	11.60	12.22	9.16	7.65
Aug 1981	307.2	296.4	276.5	—	11.84	12.12	9.18	7.74
Sep 1981	307.4	295.7	279.3	196.94	12.10	12.72	9.37	7.76
Oct 1981	309.0	296.1	279.9	—	12.08	12.45	9.36	7.82
Nov 1981	309.3	295.5	280.7	—	12.12	12.51	9.41	7.84
Dec 1981	310.0	295.8	281.5	201.22	12.07	12.48	9.51	7.92
Jan 1982	311.8	298.3	282.5	—	12.19	12.69	9.67	8.00
Feb 1982	311.6	298.6	283.4	—	12.22	12.64	9.67	7.98
Mar 1982	311.0	298.0	283.1	203.36	12.31	12.73	9.70	8.04
Apr 1982	309.9	298.0	284.3	—	12.26	12.72	9.79	8.07
May 1982	309.6	298.6	287.1	—	12.29	12.74	9.81	8.10
Jun 1982	310.6	299.3	290.6	206.15	12.28	12.95	9.94	8.14
Jul 1982	312.8	300.4	292.2	—	12.23	12.94	10.00	8.23
Aug 1982	313.2	300.2	292.8	—	12.29	13.01	10.01	8.30
Sep 1982	312.7	299.3	293.3	208.13	12.53	13.51	10.19	8.37
Oct 1982	314.3	299.8	294.1	—	12.51	13.26	10.22	8.41
Nov 1982	315.0	300.3	293.6	—	12.53	13.22	10.26	8.45
Dec 1982	315.2	300.7	292.4	210.00	12.53	13.05	10.32	8.51

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[1] US Bureau of Labor Statistics, Washington, D.C.: "Producer Prices and Price Indexes," (formerly "Wholesale Prices and Price Indexes").

[2] US Bureau of Labor Statistics, Washington, D.C.: Consumer Price Index for All Urban Consumers, US City Average, All Items.

[3] US Department of Commerce, Washington, D.C.: Bureau of Economic Analysis, National Income and Wealth Division: "Survey of Current Business." The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

[4] US Bureau of Labor Statistics, Washington, D.C.: "Employment and Earnings." All data based on 1972 revision of SIC Manual.

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ADDENDUM TO TABLE 9, PAGE 30

Please note the Strata-bound Type includes the Upper Granite Breccia Member and the Brooks Member as well as the Whenan Member and the Black Hematite Member. The Transgressive Type includes the Lower Silicified Member, the Upper Granite Breccia and the Brooks Member.

Table 9

MINERALIZED FORMATIONS AT OLYMPIC DAM[1]

Geologic Age—Middle Proterozoic
Mineralized Sequence
Strata-bound Type
Transgressive Type

Greenfield Formation	
Volcanic Member (250 m thick)	Volcanic breccias and conglomerates
Hematite Breccia Member (500 m thick)	Hematite-rich breccias and siltstones
Lower Silicified Member (275 m)	Hematite and silicifed breccias, *chalcocite* and *bornite minerals*
Olympic Dam Formation	
Upper Granite Breccia Member (100 m thick)	Hematite-rich granite breccia, *chalcocite* and *bornite minerals*
Brooks Member (300 m thick)	Mixed rock breccias, brown and black hematite matrix, *chalcopyrite, bornite and chalcocite minerals*
Whenan Member (350 m thick)	Mixed rock breccias, black and red hematite matrix, bedded units throughout, *bornite* and *chalcopyrite minerals*
Black Hematite Member (150 m thick)	Mixed rock breccias, black hematite matrix, *chalcopyrite mineral*
Lower Granite Breccia Member (800 m thick)	Granite and mixed rock breccias, chlorite alteration

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[1]Adapted from D.E. Roberts and G.R.T. Hudson, RMS, Economic Geology, August 1983.

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JANUARY 1984 NUMBER 185

Monthly Report on the Nuclear Fuel Market

NUEXCO

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EXECUTIVE SUMMARY
REPORT 185
(All data as of December 31, 1983)

Exchange Value **\$22.00, down \$0.50**	The **Exchange Value** is **\$22.00** per pound U_3O_8, down \$0.50 since last month. Two uranium sales transactions are reported, involving approximately 0.7-1.0 million pounds U_3O_8. One transaction involved concentrates and one was for enriched UF_6.
Supply-Demand Ratio **rose to 2.4:1**	Active spot and near-term **uranium supply** amounts to **5.9 million** pounds U_3O_8 *equivalent*, up 200 thousand pounds from last month. Active spot and near-term **uranium demand** totals **2.5 million** pounds. The spot and near-term **supply-demand ratio** rose to **2.4:1.**
Transaction Value **unchanged at \$23.85**	The **Transaction Value** is **\$23.85** per pound U_3O_8, unchanged since last month. It includes 16 transactions involving a total of 2.3 million pounds U_3O_8 equivalent and covers a period of 6 months. No new transactions were added to the calculation.
Loan Use Charge Rate **unchanged at 6%**	The **Loan Use Charge Rate** remains **6 percent** per annum. Two U_3O_8 loans are reported this month, involving a total of approximately 500 thousand pounds.
Conversion Value **remained at \$0.60**	The **Conversion Value** is **\$0.60** per pound U as UF_6, unchanged since last month. One secondary market conversion transaction is reported, involving approximately 100 thousand pounds U as UF_6. Active secondary market supply of conversion services for delivery within three years totals 3.4 million pounds U as UF_6; active demand amounts to 1.3 million pounds.
SWU Values **\$105 for DOE-origin (FY 84)** **\$85 for non-DOE origin** **(delivery within 15 months)**	The **SWU Values** are **\$105** per SWU of DOE origin for FY84 delivery and **\$85** per SWU of non-DOE origin for delivery within 15 months. Four SWU transactions are reported this month, involving a total of 400 thousand SWUs. Active secondary market supply of enrichment services totals approximately 900 thousand SWUs; spot and near-term demand totals 600 thousand SWUs.
Enrichment	The December 30 draft of the new Utility Services enrichment contract aims to give utilities a better deal for enrichment services while curbing the trend of DOE's loss of business. Some of the important terms of the USEC are analyzed in this Report, along with the contract's probable impact on the secondary SWU market.
Canada	The Key Lake mine and mill is producing U_3O_8 on schedule, and results of drilling at Cigar Lake in northern Saskatchewan reveal an exceptionally high-grade uranium deposit.
Italy	ENEL's most recent electricity generating plan calls for a dramatic increase in the use of nuclear power by 1995.
United States	One new unit achieved commercial operation during December and two others neared that stage.
Analysis and Commentary	The Federal Energy Regulatory Commission is considering revising its nuclear fuel accounting rules, and the revisions could have widespread implications for nuclear utilities.
Basic Considerations	DOE operates three gaseous diffusion enrichment plants in the eastern US that together are capable of producing 27 million SWUs annually.
Focus: United Kingdom	Despite having the world's oldest commercial nuclear power program, the UK currently relies heavily on coal-generated electricity. Attempts to implement a PWR program in the UK are stalled pending completion of the Sizewell B inquiry.
Focus: Japan's **Nuclear Infrastructure**	With a healthy and well-organized industrial base, Japan is now virtually self-sufficient for nuclear hardware and systems. It is on the road to becoming self-sufficient in fuel cycle services as well.
1983 Index	This Report includes an index to reports published in 1983 (173-184).

This Executive Summary may be reproduced for internal distribution.

NUEXCO REPORT 185 FIGURES OF THE MONTH (December 31, 1983)	This Month (Report 185)	Last Month (Report 184)	12 Months Ago (Report 173)
Exchange Value[1]	22.00	22.50	20.25
Transaction Value[1]	23.85	23.85	18.80
Conversion Value[2]	0.60	0.60	1.45
Loan Use Charge Rate[3]	6%	6%	6%
Near-Term Uranium Supply[4]	5.9	5.7	8.8
Near-Term Uranium Demand[5]	2.5	3.1	3.9
Near-Term Supply-Demand Ratio	2.4	1.8	2.3
Recent Uranium Sales:			
Number of Transactions[6]	2	5	9
Quantity of material[7]	0.7-1.0	5.4-9.0	8.7-22.4
Nuexco SWU Values:[8]			
DOE origin, FY 84 delivery	105	110	
non-DOE origin, delivery within 15 months	85	90	
USDOE SWU Prices:			
AFC	138.65	138.65	138.65
Requirements	149.85	149.85	149.85
Market Value of Enriched UF$_6$[9] [10]:			
2.5 w/o U$_{235}$	603.70	653.63	693.19
3.0 w/o U$_{235}$	774.39	838.93	895.97
3.5 w/o U$_{235}$	948.22	1,027.67	1,102.91
4.0 w/o U$_{235}$	1,124.37	1,218.95	1,312.91

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[1] US $ per pound U$_3$O$_8$ equivalent.

[2] US $ per pound U as UF$_6$.

[3] Per annum.

[4] Active inquiries to sell, for delivery within 12 months after contract signing (millions of pounds U$_3$O$_8$).

[5] Active inquiries to purchase, for delivery within 12 months after contract signing (millions of pounds U$_3$O$_8$).

[6] Uranium sales only; does not include loans, conversion, or SWU transactions.

[7] Millions of pounds U$_3$O$_8$, equivalent.

[8] US $ per SWU.

[9] Calculated using the Nuexco Exchange Value, Conversion Value, and 0.20 percent tails assay. Calculations before 2/28/83 used the USDOE price for AFC SWUs. From 2/28/83 through 9/30/83, calculations used the Nuexco SWU Value for the relevant fiscal year. As of 10/31/83, calculations use the SWU value for DOE origin and FY 84 delivery.

[10] US $ per KgU as UF$_6$.

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THE IMPORTANCE OF BY-PRODUCT URANIUM TO PHOSPHATE ROCK PRODUCERS

By

M.J. Reaves
Vice President
Nuexco

Presented To:

Industrial Minerals Conference

Phosphates: What Prospects for Growth

Orlando, Florida
December 13, 1983

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THE IMPORTANCE OF BY-PRODUCT URANIUM TO PHOSPHATE ROCK PRODUCERS

By

M.J. Reaves
Vice President, Nuexco

How important is by-product uranium to phosphate rock producers? Not very important right now, but it could be.

The Old Days

Phosphate rock in Florida and the western US averages 0.015 percent U_3O_8 with isolated concentrations as high as 0.10 percent U_3O_8. As recently as 1979, there were as many as 12 uranium recovery operations under construction, in various stages of planning, or operational in the US. Uranium prices had catapulted from the $6-8 per pound level in the early 1970s to over $43 per pound by 1979. Phosphate rock producers weren't the only ones that noticed the price rise. Companies around the world were scrambling to get into uranium exploration and production, most notably the major oil companies. Exxon, Gulf, Phillips, Sun, Texaco, Mobil, Sohio, Chevron, Conoco, Kerr-McGee, Union, Tenneco and Arco were all participants.

In January of 1980 Nuexco published a summary outlining plans for uranium recovery from phosphoric acid alone, shown here in Table 1. UNC Recovery Corporation, Wyoming Minerals and Gardinier had plants already operating in Florida. Freeport was operational in Louisiana. IMC's three plants in Florida were nearing startup and there were 3 facilities planned for Idaho by Becker Industries, Earth Sciences and Simplot. Nearly five million pounds U_3O_8 production per year was planned from phosphates.

Table 1

OPERATIONS FOR RECOVERY OF URANIUM FROM PHOSPHORIC ACID, JANUARY 1980

Company	Plant Location	Capacity (lbs. U_3O_8/yr.)	Status
UNC Recovery Corp. at W.R. Grace & Co.	Bartow, Fla.	330,000	Operational
Wyoming Mineral Corp. at Farmland Industries	Pierce, Fla.	400,000	Operational
Freeport Uranium Recovery Co.	Uncle Sam, La.	690,000	Operational
Freeport plant at Agrico Chemical Co.	Donaldsonville, La.	420,000	Start-up mid-1980
Gardinier Inc.	Tampa, Fla.	425,000	Operational
International Minerals & Chemical Corp.	New Wales, Fla.	800,000	Start-up March 1980
IMC plant at C.F. Industries, Inc.	Plant City, Fla.	600,000	Start-up by early 1981
IMC plant at C.F. Industries, Inc.	Bartow, Fla.	600,000	Start-up by early 1981
Earth Sciences, Inc. at Western Cooperative Fertilizers, Ltd.	Calgary, Alberta	120,000	Start-up early 1980
J.R. Simplot Company at Don Plant	Pocatello, Idaho	120,000	Construction begins mid-1980
Earth Sciences, Inc. at Western Cooperative Fertilizers, Ltd.	Medicine Hat, Alberta	120,000	Option to build
Becker Industries Corp. at Conda Mine area	Conda, Idaho	200,000	Pilot test planned
TOTAL CAPACITY, OPERATIONAL AND PLANNED		4,825,000	

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Prices Plunge

By mid-1982 the entire picture had changed. Uranium spot prices, as measured by the Nuexco Exchange Value, declined to a low of $17 per pound in August and September of 1982. It's pretty evident why this price drop occurred.

Actual worldwide uranium production during 1982 was 106 million pounds, most of which was produced to meet delivery obligations under contracts executed in prior years. Uranium consumption during 1982, however, was only 63 million pounds and will not approach 100 million pounds until 1987 or 1988.

We had an industry capable of making 150 milllion pounds, which was actually making 106 million pounds when only 63 million pounds were actually needed. The difference between production and consumption (some 43 million pounds) was being added to inventory, bringing total inventory to more than 400 million pounds, or equivalent to nearly 6 years forward usage. Someone, somewhere is holding that inventory with all the attendant carrying charges. Compare this with 90-day inventories of oil or 120-day coal stockpiles.

This is oversimplified, but sales of inventory competing with primary producers contributed to the price drop. The industry underwent an abrupt and violent contraction and is fundamentally different today than it was. Most of the oil companies I listed earlier are out of the business or will be soon. Only Chevron, Kerr-McGee, Tenneco and Mobil are now producing, and I have doubts about the longevity in the business of some of these companies that remain. US production in 1983 is expected to be about 19 million pounds. The typical uranium producer in the future (at least in the US) is likely to be a smaller company, producing under 1 million pounds U_3O_8 per year.

Most of the projects to recover uranium from phosphates didn't materialize either. In 1982 International Minerals and Chemical Corporation (IMC) and Freeport Uranium Recovery Corporation collectively produced and sold about 2.5 million pounds U_3O_8. This represented about 10 percent of total US uranium production.

Last fall, production also resumed at the Earth Sciences, Urangesellschaft joint venture uranium recovery plant at Calgary, Alberta. This plant is expected to produce about 100,000 pounds U_3O_8 per year. The plant utilizes phosphoric acid produced by Western Cooperative Fertilizers from phosphate rock mined in Idaho.

These companies all signed favorable long-term sales contracts with utilities when prices were high, which enabled them to survive. This is also true of most of the conventional miners of uranium in the US that survived. Almost no one in the US can produce and sell uranium at a profit for $17 per pound.

Uranium contracts based on phosphate production were considered exceptionally desirable contracts by buyers. This was true because phosphate producers could contract for 15 years or more (as long as the phosphate lasts, if they wanted to), while conventional producers were usually willing to contract only 5 to 10 years because of resource or production limitations.

Outside the US

US utilities can buy from foreign uranium producers, but not without assuming some risks. Foreign sellers may be subjected to a variety of economic, political or social circumstances that could limit or eliminate buyer interest. Canada, for instance, will allow uranium to be exported only in the upgraded form of UF_6. Many US utilities take exception to this policy because they already have long-term conversion contracts with US converters. Substantial Canadian uranium has already been sold in the US, but this policy has recently stalled new imports from Canada.

The uranium producing nations in Africa are South Africa, Namibia, Niger and Gabon. Each nation could definitely be a seller to US utilities and a limited amount of South African material has already been sold in the US. However, each nation has complex political, social and economic problems, which make them less attractive to some US buyers. American attitudes are influenced by pressure from political groups as well as by internal policies.

Australia, of course, has the world's largest known uranium resources. The two operating mines have a combined production of 11 million pounds per year. Very little of that production has been sold to US utilities. Development plans of other important deposits are currently caught up in unfavorable industry economics and the political opposition of the Labor Party. Those two problems will probably keep Australia out of the US market for at least the next five to ten years.

Future Demand for Uranium

The United States represents the largest market for intermediate and long-term unfilled requirements.

Uranium consumption, of course, is a direct function of in-place nuclear generating capacity. Uranium is a unique mineral. It has only one industrial use, which is as the principal fuel commodity for nuclear power.

Nuclear generating capacity will increase in the US

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from the installed 58 GWe in 1982 to about 111 GWe by 1992. Further growth this century almost certainly will not occur because additional plant orders are not expected before 1990. Plant lead time is presently 12 to 14 years, but this could decrease to 8 to 10 years if licensing procedures are streamlined. Expected increased uranium consumption is based solely on plants operating or under construction now, but it is still substantial.

The US had large nuclear construction programs underway prior to the "energy crisis" of the mid-1970s. These programs were cut back considerably by lack of electrical load growth due primarily to energy conservation and a sluggish economy. In the US alone, 101 plants have been canceled since 1975 (out of 251 plants ordered since 1955).

Nuclear power offers considerably greater economic advantage in Europe and the Far East than in the US. Even so, the growth of nuclear power in these areas has not been consistent. Only two countries currently have sustained nuclear programs, France and Japan. France has the most aggressive building program, presently at 24 GWe and increasing to almost 63 GWe by 1996. Nuclear capacity may comprise 60 percent of France's electric generating capacity by that time. By comparison, nuclear capacity in the US will represent only 15 percent or less of total generating capacity by 1996.

The amount of installed electric capacity in West Germany is among the largest in Europe. It was developed over the years to support Germany's large industrial base. However, the West German nuclear power program has been affected adversely by regulatory and licensing problems. The need for nuclear power was also postponed as a result of long-term development of low-grade coal resources and more recently, the availability of North Sea oil. Now, nuclear power appears to be the only remaining alternative and the German nuclear program is gradually moving forward. It is expected to more than triple from the 1982 level of 10 GWe to approximately 36 GWe by 1996.

It is generally concluded that nuclear power programs throughout the rest of Europe will continue to move forward, but on greatly diversified schedules. Spain and Italy are faced with curtailed programs due to political and plant siting problems, but both have plans to expand throughout the 1980s and 1990s. The construction program in Sweden is developing on a schedule to increase from the 1982 capacity of 6.8 GWe to 9.4 GWe in 1988.

In the Far East, Japan is totally dependent on imported energy resources. The disruption of oil deliveries in the early 1970s created new incentives for Japan to diversify its electric power base. The Japanese are converting oil-fired plants to coal and are building new coal, hydro and nuclear plants. Japanese nuclear power capacity of 17 GWe in 1982 is projected to increase to 46 GWe by 1996. Korea and Taiwan also had aggressive construction programs which were only recently curtailed for economic reasons.

Back to the US

The US utility remains the key to the recovery of the uranium industry. Other countries have been far more aggressive in obtaining long-term uranium supplies. As a result, the largest and somewhat disproportionate share of uncovered requirements are in the US. Nuexco now estimates that US utilities' *unfilled* requirements will increase annually from three million pounds in 1983 to over 30 million pounds by 1994.

Uranium spot prices are presently at $22.50 which remains well below the level required to justify most new production ventures or the reopening of shut-down properties. This is especially true in the US where the cost of production is no longer competitive with many non-US producers. US utilities may be forced to import uranium to meet their requirements.

"Where does all this put US buyers?" ". . . wishing there were more US producers to buy from," which brings me around to the point of this paper.

The long-term prospects for US uranium sellers are improving. Additional US production will be necessary and long-term contracting terms are starting to reflect this fact. A recovery in uranium prices is likely around 1985. The US uranium industry will soon be incapable of supplying unfilled US requirements without the reentry of new producers. Higher prices will be necessary. It may be time to look at uranium by-product recovery again. There is going to be a market for it.

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MONTHLY · REPORT ON THE NUCLEAR FUEL MARKET
January 1984 No. 185

R. WESLEY MILLER, *EDITOR* JAMES J. LIGHTNER, *ASSOCIATE EDITOR*

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To Our Readers

Included with this Report is a copy of a speech entitled "The Importance of By-Product Uranium to Phosphate Rock Producers," which Mr. Jerry Reaves, the director of Nuexco's brokerage operations in the Southeastern United States, delivered to the Industrial Minerals Conference in Orlando, Florida on December 13, 1984.

* * *

We at Nuexco wish you a happy and prosperous 1984.

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NATURAL URANIUM

The **Exchange Value** as of December 31, 1983 is **$22.00** per pound U_3O_8, down $0.50 since last month. The *Current Market Data* section of this Report lists two uranium sales, involving approximately 700 thousand to 1 million pounds U_3O_8 *equivalent.* One transaction involved concentrates and one enriched product.

Active supply of uranium for spot and near-term delivery totals **5.9 million** pounds U_3O_8 as concentrates or natural UF_6. **Active demand** for spot and near-term delivery totals **2.5 million** pounds U_3O_8 or equivalent UF_6. The spot and near-term **supply-demand ratio** rose to **2.4:1.**

The **Transaction Value** as of December 31, 1983 is **$23.85** per pound U_3O_8, unchanged since last month. The current Transaction Value includes 16 transactions involving a total of 2.3 million pounds U_3O_8 or equivalent UF_6 and covers a period of 6 months.

The **Loan Use Charge Rate** as of December 31, 1983 is **6 percent** per annum, unchanged since last month. Two uranium loans are reported this month, involving a total of approximately 500 thousand pounds U_3O_8.

* * *

The Exchange Value fell $0.50 during December as sellers continued their efforts to stimulate buyer activity by lowering their offering prices. There was little near-term buying activity, a fact supported by the absence of new transactions for inclusion in the Transaction Value calculation. One substantial long-term sale of natural uranium is pending but is not included in this Report. Approximately half of the uranium actively for sale in the near term is in the form of natural UF_6, while active buyers in general have indicated a preference for concentrates.

* * *

After bottoming in the third quarter of 1982, the Nuexco Exchange Value recovered steadily for 12 months, reaching $24.00 per pound in the third quarter of 1983. In the fourth quarter, however, renewed inventory selling and slack demand led to new price erosion.

Factors of consequence in the current market include:

1. The contraction of the US uranium production sector has reduced the number of producer buyers, which were a major force in absorbing liquidated inventory in the past. The remaining US producers tend to fall into one of three categories: low-cost in-situ operations, by-product producers, and conventional miners committed to remaining in the uranium business.
2. Near-term utility demand is minimal. When specific requirements do emerge, the competition to make the sale has been spirited and marked by price cutting.
3. Large new quantities of inventory have become available as a consequence of the developing secondary market for enrichment services. De-enrichment swaps have liberated uranium which was previously thought of as "off the market" as a consequence of its being in the form of enriched product.
4. Much of the available inventory is in the form of natural UF_6 and is being forced into a market that is more interested in U_3O_8, causing price discounting in UF_6, which has influenced U_3O_8 prices.
5. A number of former US producers are holding substantial inventories left over from previous production operations. Without customers and with no plans to restart production, their inventories most likely will be liquidated in the near term.
6. Few US utilities seem concerned about contracting to fill their substantial unfilled requirements for the 1985-90 period. In general, utilities appear relaxed about the supply situation because of the available inventory and the downward pressure it continues to exert on prices.

The gap between spot prices and the prices required by producers for longer-term contracts is apparently not yet large enough to motivate early procurement strategies. However, if inventory holders continue to liquidate, spot prices may fall to a level that will initiate such "buy and hold" strategies. To the extent such activity takes place, it will exert upward pressure on prices. Whether that pressure would be enough to offset the downward pressure of excess U_3O_8 and UF_6 inventories remains to be seen.

* * *

The *Pricing* and *Recent Transactions* sections of Report 184 refer to two recently completed long-term contracts between an Australian producer and US utilities. The contracts were formally approved by the Australian government on November 9, 1983. The two contracts have been the subject of some interest since they appear to have resolved an apparent impasse between buyer and seller. On the one hand is the requirement that Australian-origin uranium not be exported at a price less than the Australian floor price (currently approximately US $35 per lb. U_3O_8). On the other hand is the reluctance of US utilities to accept any substantial financial exposure under an agreement having a price mechanism that requires the buyer to pay in excess of the market price (as represented by the Nuexco Exchange Value).

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PRICING

While the details of these two contracts are confidential, it is possible, based on public information (much of it previously reported), the identity of the US utilities, and the known policies of the Australian government, to make certain informed observations.

1. Any uranium exported from Australia to fulfill deliveries under these contracts will be priced at the Australian floor price, even if the market price is lower.
2. Deliveries will not be subject to cancellation or postponement if the Australian floor price is higher than market price. However, there is almost surely considerable flexibility in establishing delivery quantities, so that the buyers can limit financial exposure during periods of low market prices.
3. It is likely that the term of these contracts is a series of two or three-year options which can be taken up sequentially.
4. The inclusion of a debit/credit scheme suggests the existence of some mechanism, based either on pounds delivered or dollars credited, that could trigger certain adjustments or options to adjust one or more of the commercial terms and conditions of the agreement.
5. The contracts could provide for the supply, under certain circumstances, of non-Australian material at market-related prices.
6. The basic price provision probably calls for the buyers to pay the higher of a market-related price or the Australian floor price. Such a market-related price probably would be subject to progressively larger discounts as the market price exceeds the Australian floor price by progressively larger margins.

While at first glance such an arrangement might not appear to make sense for either party, there are advantages to each. The seller has gained market share using marginal production. A worst case situation is delivery of a sharply reduced amount of material. Best case is two long-term contracts and substantial credibility in the US market. The utilities, with limited financial exposure, have gained the opportunity to diversify in an uncertain market and assure a long-term source of supply on particularly attractive terms, if prices do, in fact, move sharply higher in the longer term.

SECONDARY MARKET CONVERSION SERVICES

The **Conversion Value** as of December 31, 1983 is **$0.60** per pound U as UF_6, unchanged since last month. The *Current Market Data* section of this Report lists one secondary market sale of conversion services, involving approximately 100 thousand pounds U equivalent. Active secondary market supply of conversion services for delivery within three years totals 3.4 million pounds U as UF_6, while the corresponding demand figure is 1.3 million pounds. The large active supply of UF_6 in the market continues to keep downward pressure on the Conversion Value. Activity in the market has been sparse for the past several months.

SECONDARY MARKET ENRICHMENT SERVICES

The secondary market **SWU Values** as of December 31, 1983 are **$105 for DOE origin** and FY 84 delivery, and **$85 for non-DOE origin** and delivery within 15 months. The Value for DOE origin SWUs fell $5 from last month, as did the Value for non-DOE origin SWUs. The *Current Market Data* section of this Report lists four SWU transactions involving a total of approximately 400 thousand SWUs. Active secondary market supply of enrichment services totals approximately 900 thousand SWUs, and active demand amounts to approximately 600 thousand SWUs.

* * *

The SWU Values declined during December as sellers lowered offering prices in competition for the few remaining buyers for FY84 deliveries. While active demand for delivery within one year amounts to 600 thousand SWUs, little of that quantity applies to DOE FY84 SWUs. None of the four SWU transactions listed in this Report involve FY84 SWUs. Thus, downward pressure on the SWU Value probably will increase during the next 60-90 days, after which time the secondary market for DOE FY84 SWUs will virtually evaporate (due to DOE's 180-day notice requirement). During December many buyers continued to await issuance of the Utility Services enrichment contract (USEC). DOE issued a draft of the new contract on December 30.

POSSIBLE EFFECTS OF THE USEC ON THE SECONDARY SWU MARKET

The USEC is still in draft form, as are the terms and conditions for conversion from existing DOE contracts. Because many changes may be forthcoming before the final contract version is submitted to Congress (late this month), the level of uncertainty in the market remains high as this Report goes to press. It is possible, however, to project likely trends in the secondary market based on the preliminary terms and conditions.

In the short term there will continue to be *some* buyers willing to pay a substantial premium for DOE origin

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SWUs, in particular the few holders of modified Interim Sales contracts (ISCs), who will continue to fill their FY84-85 requirements. The basis of the two-tiered price structure of the secondary market will tend to erode, however. The two-tiered market developed after DOE issued the modified ISC in October, 1983. The modified ISC allows free substitution (no termination charge) of *DOE origin* secondary market SWUs for up to 40 percent of requirements in FY84 and up to 60 percent of requirements in FY85. As a result, DOE origin SWUs sold for $20 more per SWU than non-DOE origin SWUs in the fourth quarter of 1983. At present it appears that the modified ISC will no longer be available to 3.5-year Requirements contract holders unless they requested the ISC before DOE issued the draft USEC on December 30, 1983. The modified ISC is a "mini-deal" in that it gives customers attractive terms provided they intend to convert to the USEC. Existing DOE customers that want to convert to the USEC are required to do so (or notify DOE of their intention to do so) by July of this year. Without the continued presence of the modified ISC offer, the cause of the two-tiered market will not be sustained after the few existing ISC holders complete their secondary market purchases.

The USEC requires that 100 percent of the customer's requirements be taken directly from DOE at least through FY85 (except as such requirements may be reduced by existing inventories, assignments and ISCs). Therefore, the only potential large buyers of secondary market SWUs will continue to be 3.5-year Requirements holders who do not convert and who wish to terminate deliveries and pay termination charges. While US buyers in general would continue to pay some small premium for DOE origin SWUs, sellers of non-DOE origin SWUs, who led the market before the ISC was issued, should continue to dominate the market. In effect, the USEC does nothing to make DOE origin SWUs relatively more attractive, so prices in the two market sectors would tend to converge over the long term.

The price at which the secondary market would stabilize would depend on a number of factors. The 3.5-year Requirements contract holders will have three options:

1. taking SWUs under the existing Requirements contract;

2. converting to the USEC and accepting a savings of at least $149.85 - $135 = $14.85;

3. terminating and buying replacement SWUs in the secondary market.

For termination and secondary market participation (option 3) to be the most attractive choice, buyers would have to see a net savings after payment of termination charges (0.25 x $149.85 = $37.46 per SWU) that exceeded the net price savings of the USEC ($14.85). Secondary market prices would have to be *below* $149.85 - $37.46 - $14.85 = **$97.46.**

The current price level for non-DOE origin SWUs is near $85 per SWU. Few DOE origin SWU sellers, if any, will compete with non-DOE sellers at prices near that level. The conversion terms of the USEC as drafted allow AFC holders that convert to adjust their AFC commitments (and possible carrying costs) after FY86 by taking only their requirements (thus eliminating excessive commitments), decreasing further the incentive to sell at discounts competitive with non-DOE origin prices. Therefore, future secondary market SWU prices are likely to be based on competition among non-DOE sellers alone.

TERMS AND CONDITIONS OF THE DRAFT USEC

Introduction

This article presents Nuexco's analysis of the draft Utility Services enrichment contract (USEC). It is important to recognize that it is based only on a reading of the contract language. Numerous areas of inconsistency, imprecision or lack of definition remain to be resolved, either by changes in the contract language or by DOE policy rulings.

Terms of Conversion

Current DOE contract holders must convert to the USEC by July 1, 1984, if they wish to obtain the terms and conditions specified in this draft. New DOE customers must sign the USEC at least 18 months prior to the FY of first deliveries. The USEC applies to *all* current and future nuclear reactors owned by the customer for 30 years or until end-of-life of the plant(s), whichever comes first. With the current wording, the USEC draft implies that if a DOE customer holds an AFC contract and a Requirements contract, changing one contract over to the USEC will force the customer also to convert the other contract to the USEC. Beginning in FY89, the terms of the USEC will apply equally to all DOE customers that signed it. In the meaintime, the following terms of conversion will apply.

1. AFC contract holders that convert must accept *without reduction* 100 percent of the commitments through FY86 as defined in the current AFC Appendix A. For FY87 and FY88, the commitments defined in Appendix A may be reduced to match no less than 100 percent of the

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customer's actual requirements. If, prior to conversion to the USEC, Appendix A commitments in FY87 and FY88 are less than actual requirements, they may be left unchanged by the customer, *but only for the express purpose of reducing inventory*. At present, there is some feeling within the industry that DOE *might* be willing to grant some further relief on this point in the final USEC.

2. Requirements contract holders that convert must purchase 100 percent of actual requirements through FY86 from DOE, and at least 70 percent after FY86. These commitment levels may be offset in FY84-88 by termination notices, assignments and ISCs signed prior to December 30, 1983. DOE has indicated that the ISC offer to all 3.5-year Requirements contract holders is no longer available. DOE *will* honor all requests for the ISC made *before* the issuance of the draft USEC.

Pricing

SWU prices for USEC holders will conform to DOE's existing pricing policy. Prices will not exceed the fixed ceiling charge of $135 per SWU adjusted annually at a rate based upon changes in the US GNP Implicit Price Deflator (GNPIPD). The first adjustment will be made on October 1, 1985 (the ceiling will be $135 per SWU for FY84 and FY85). A new price ceiling willbe defined as of the first day of each FY by multiplying $135 by the ratio of the GNPIPD in the third quarter of each calendar year to the GNPIPD in the third quarter of calendar year 1984. On the first day of the FY the GNPIPD for the next quarter will not be a known statistic. As a result, price ceiling changes may require further adjustments at a later date.

Upon three years advance notice, DOE may adjust the ceiling (possibly raising it beyond the changes allowed by the above price protection formula). In such a case, customers could reduce contract commitments by *any amounts* without incurring termination charges.

Termination Charges

Five years after the start of the FY in which first deliveries were scheduled to occur under the USEC, if the customer has had no requirements for enrichment services, DOE may terminate the contract. In such a case contract advance payments of $500 per MWe capacity together with any accurals would be forfeited to DOE.

Customers that cancel deliveries when actual requirements for enrichment services exist or are anticipated will be assessed the greater of two charges:

1. advance payments and accruals, less payment of amounts contracted to DOE;

2. a charge equal to the price of one SWU (S) minus the price component representing the energy portion of the electric power charge (E) times the number of cancelled SWUs (C) times a multiplier (M) that is based on the notice period given by the customer.

$$\text{Termination Charge} = (S - E)(C)(M).$$

(M) is equal to 1 if the contract is terminated within one year of scheduled delivery, and it is equal to a progressively smaller fraction of 1 with each year of advance notice (0.9 if notice is between 1-2 years, 0.8 if between 2-3 years, etc.) up to 9 years notice, after which it is constant at 0.1.

As the termination charge formula is based on the number of cancelled SWUs, partial termination, as opposed to contract termination, appears as an acceptable option. Charges for complete contract termination with intent to turn to an alternate supplier could be prohibitively costly due to the minimum termination charge.

VTAO Charge

The current standard tails assay is 0.2 w/o, but the customer may elect the Variable Tails Assay Option (VTAO). DOE must be informed if the customer elects the VTAO at least 18 months in advance of the FY to which it would apply (actual tails assay may be specified at a later date). Although the VTAO is available, a graduated VTAO surcharge could effectively reduce the possible advantages of exercising the VTAO (see the following article for an analysis of the potential impact of the USEC tails specifications on future uranium consumption). The charge is equal to 0.007 times the SWU cost for each 0.01 weight-percent selected by the customer above 0.2. If the SWU price is constant at $135, the charge is $0.95 per SWU for each 0.01 w/o increase in the tails assay.

The VTAO surcharge could have a substantial influence on the breakeven secondary market SWU price for a buyer considering partial termination. It is conceivable that secondary market SWUs specifying high tails assays (upwards of 0.3 w/o) would be more economical than contracted USEC SWUs. The parameters involved in the calculation of the breakeven price would be the perceived value of feed material, the VTAO charge, and partial termination charges combined with secondary market SWU prices.

Leadtime Terms

1. 10 years or more in advance of a FY of delivery, the

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minimum commitment in effect in the contract may be reduced at no charge by up to 10 percent, down to a minimum of 70 percent of requirements.

2. At least 18 months prior to the FY of first delivery, the customer must advance payment of $500 per MWe of rated or anticipated capacity. There is no indication that the advance payment is prorated with the portion of requirements covered by the contract if that portion is less than 100 percent.

3. At least 18 months in advance of each FY of delivery the customer must provide updated specifications of monthly quantities and assays of required product for a subject FY. Additionally, it must indicate preferred dates for delivery of feed to DOE and inform DOE if it will elect the VTAO. Also, the customer must give DOE its estimated SWU requirements for the subsequent 10-year period, along with an update of plant operating schedules, fuel cycle data, enriched inventories, and inventory destinations if product was purchased under the USEC (Attachment 1 to Appendix A).

4. At least 180 days prior to anticipated delivery, the customer must firm up the specific quantities and assays of enriched product to be delivered and finalize delivery dates. If the VTAO has been elected, the customer then specifies the desired transaction tails assay between 0.2 and 0.3 w/o.

5. No more than 10 days after receipt of the customer's firmed up requirements, DOE will advise the customer if it disagrees with the reasonableness of the customer's specifications. No more than 15 days after such receipt, DOE may advise the customer of new delivery dates (in the case that total scheduled deliveries exceed DOE's capacity).

6. As in all DOE contracts, the customer must deliver feed in proportions specified by DOE at least 90 days prior to the beginning of an agreed delivery month. However, in a significant reversal of previous practice, DOE has inserted in the USEC draft a provision which limits and perhaps even eliminates the customer's freedom to supply material pre-enriched by other than DOE.

7. On the actual product delivery date or the delivery date requested by the customer, whichever is later, DOE may invoice the customer for all amounts due for services provided. Within 30 days of the invoice date but no later than the last day of the FY, the customer must pay all amounts due or late payment charges will be assessed.

8. Upon "reasonable" notice, DOE may terminate the contract at no cost if commercial enrichment services become available in the USA.

IMPACT OF THE DRAFT USEC ON URANIUM CONSUMPTION

Introduction

During the past few months, the USEC has been presented by some as an opportunity to develop a powerful tool to increase uranium consumption and help pull the US uranium producer sector out of its current slump. One contract mechanism considered for increasing consumption was to allow utilities to select individually the optimum tails assay for their enrichment services. Preliminary analyses showed that allowing utilities to select optimum tails assays for their enrichment contracts could have had the effect of increasing U_3O_8 consumption in the United States by as much as 50 million pounds over the next ten years, doubling the unfilled requirements for US utilities over this period.

With the draft of the USEC available for comment, it has become apparent that those hopes were misplaced. The contract's fine print has taken away the potential gains in uranium consumption and replaced them with potential losses. To evaluate the impact of the USEC on uranium consumption it is necessary to address separately the three changes to the contract which contribute to changes in uranium demand:

1. the Variable Tails Assay Option (VTAO);
2. the flexibility terms which allow customers to adjust their enrichment services to meet their actual requirements;
3. flexibility to obtain enrichment services from other sources.

Effect of Optimum Tails Assay

The cost of enriched uranium is the sum of the feed and enrichment costs, and the optimum tails assay is that tails assay for which the total cost is minimal. Without VTAO charges and with current uranium and SWU prices, a utility can save more than $1 million per reload batch by increasing its enrichment tails assay from 0.2 weight-percent (w/o) to 0.3 w/o. Not only does this change in tails assay reduce the ultimate cost of electricity to consumers, it also increases uranium consumption by approximately 20 percent. (For more background on separative work units and the optimum tails assay see Report 184, pages 17-19.)

The draft USEC contains a VTAO provision but also levies a surcharge for tails greater than 0.2 w/o (see page 4 of this Report). Adding the surcharge, a customer that specifies a tails assay of 0.3 w/o would have an effective

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PRICING

SWU base price of $144.45, seven percent higher than the $135 base price referred to in the contract. The VTAO surcharge has the effect of reducing the optimum tails assay and reducing the consumption of uranium.

In defense of DOE, higher tails assays reduce the number of required SWUs, and the apparent intent of the surcharge is to cover the fixed costs associated with SWUs not delivered when the VTAO is selected. The proposed surcharge is plotted in Figure 1 as a percentage of the price for the SWUs not delivered. While it varies somewhat with enrichment and tails levels, the surcharge is approximately 30 percent of the price of the SWUs that are not delivered as a result of exercising the VTAO.

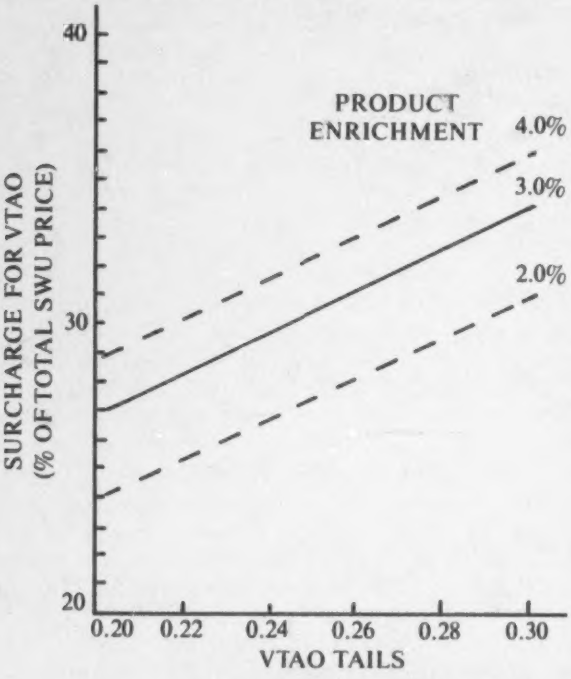

Figure 1
VTAO SURCHARGE IN TERMS OF THE PRICE OF SWU s NOT TAKEN

The effect of the proposed surcharge is complex to evaluate, and is a weak function of the product enrichment level. The impact is most readily understood and approximated by assuming that the surcharge is indeed 30 percent of the price of the SWUs that are not delivered as a result of exercising the VTAO. A good approximation of the optimum tails assay with the surcharge can then be found from previous studies (such as Figure 4 in Report 184, page 19) by replacing the *unit cost of SWUs* with *70 percent of the unit cost of SWUs*. Conceptually, the optimum tails assay curves are being used with the *variable cost* of SWUs as input, rather than the total cost.

Assuming a SWU price of $135, a conversion cost of $3.00 per pound of uranium, and a product enrichment of 3.0 w/o, Table 1 shows the effect of the surcharge on the optimum tails assay as a function of the price of uranium. The results of the approximate evaluation method are also shown to give an indication of its accuracy.

The net impact of the proposed VTAO surcharge is to reduce the optimum tails assay by about 0.04 w/o, thus reducing the uranium demand by about 7 percent. For uranium costs near or above $50 per pound U_3O_8, the optimum tails assay based on the variable cost of SWUs is less than 0.2 w/o, but DOE does not offer a credit for the extra SWUs delivered, keeping the practical optimum at 0.2 w/o.

In evaluating the impact of the USEC's VTAO terms on domestic uranium consumption, it is important to understand the current situation. In the USA, approximately 45 percent of the SWUs to be delivered to US customers are under the AFC type of contract, while the remainder are under two types of Requirements contracts. The AFC contract holders are allowed to vary tails from 0.16 w/o to 0.3 w/o at no charge, and these customers have indicated that they plan to use the VTAO, with a weighted average of 0.28 w/o tails, for about 80 percent of their enrichment services over the next decade. The Requirements contract holders are currently restricted to 0.2 w/o tails from DOE, but a number of these customers are canceling their DOE deliveries and buying SWUs in the secondary market, some of them at higher tails assays. Neglecting this last effect, the weighted average tails assay for US customers is about 0.23 w/o.

The impact of the USEC's VTAO terms depends on DOE's success in converting the current contract holders, and on the relative cost of uranium and enrichment. However, it is possible to evaluate some bounding assumptions and the relative impact of the VTAO surcharge.

1. If all US utilities used 0.3 w/o assays, uranium consumption would increase by about 14 percent, or 50 million pounds U_3O_8 over the next ten years.

2. The impact of the proposed VTAO surcharge would be to reduce the optimum tails assay by 0.04 w/o and thus reduce uranium consumption by about 7 percent, compared to a VTAO without the surcharge. If all domestic AFC holders converted to the USEC, the expected average tails assay would be about 0.24 w/o (the current average

Table 1

EFFECT OF VTAO SURCHARGE ON OPTIMUM TAILS ASSAY

U_3O_8 Cost ($ per lb.)	Optimum Tails without Surcharge (w/o U_{235})	Optimum Tails with Surcharge (exact w/o U_{235})	Optimum Tails with Surcharge (approx. w/o U_{235})
20	0.32	0.28	0.28
25	0.30	0.26	0.26
30	0.28	0.24	0.24
35	0.26	0.23	0.22
40	0.25	0.21	0.21
45	0.24	0.20	0.20
50	0.23	0.20	0.20

of 0.28 w/o less the reduction of 0.04 w/o due to the surcharge). Thus, the best the industry could hope for would be an overall consumption increase of 1-2 percent.

3. The customers most likely to convert to the USEC are the AFC contract holders, which currently have the VTAO without the surcharge. The effect of the surcharge will be to reduce uranium consumption from this class of customer.

Effect of Delivery Flexibility

Another potential impact of the USEC on uranium consumption will be the new delivery flexibility terms for customers who convert from AFC contracts. The AFC contract holders are currently committed to take a fixed quantity of SWUs from DOE through FY88, regardless of their actual requirements. While some of these customers have been able to adjust their deliveries to meet their expected requirements, others are required to take excessive SWUs (and deliver excessive feed to DOE) to meet their fixed commitments.

The conversion terms from the AFC contract to the USEC do not provide any relief from AFC commitments through at least FY86. In FY87 and FY88, the terms apparently allow customers to reduce their commitments if the committed amount *for that year* is greater than the actual plant requirements, but do not allow them to use their accumulated excess inventory until FY89. The net anticipated impact of the new flexibility terms should be a slight reduction in FY87 and FY88 demand. For FY89 and beyond, there will be some further reduction in demand, as the USEC's flexibility terms provide a more efficient method for consuming excess inventories of enriched material. Requirements contract customers have never been forced to take excessive SWUs, so their uranium demand should not change with the new flexibility terms.

Effect of Supply Flexibility

The USEC will ultimately allow customers to take up to 30 percent of their requirements from other sources than DOE, including non-DOE primary enrichment facilities and non-DOE SWUs from the secondary market. US producers are concerned that this flexibility will facilitate the import of foreign uranium, as the non-DOE SWUs may be purchased in the form of enriched product derived from non-domestic feed material. This effect is difficult to evaluate, as it is dependent on the relative future prices of both SWUs and uranium worldwide. Currently, domestic customers are meeting about 12 percent of their requirements with non-DOE SWUs. Many of these transactions are in the form of de-enrichment swaps, where enriched material of foreign origin is exchanged for feed material from the US utility, with no net import or export of uranium.

Summary

In summary, the draft USEC offers at best a 1-2 percent increase in uranium consumption from the VTAO terms, with a probable slight loss in consumption if only the AFC contract holders convert. This percentage contrasts with a potential increase of 14 percent were tails assay specifications more flexible. There are also expected losses in the demand for US origin uranium from the delivery and supply flexibility terms of the USEC.

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CURRENT MARKET DATA

EXCHANGE VALUE $22.00/lb. U_3O_8
Determined as of December 31, 1983

Definition[1]

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

[1] In December, 1981, Nuexco published a history of the Exchange Value which chronicled, month-by-month, changes in its definition, usage and derivation. Copies are available upon request.

TRANSACTION VALUE[2]
Determined as of December 31, 1983

$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
23.85	2.3	16	6

Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

Comments

Nuexco does not consider the following in determining the Transaction Value:

A. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.
B. The price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of Exchange Value or any other independent variable. Also excluded from consideration are all data where the delivery price is defined in such a way that it cannot currently be determined.

[2] Transaction Values for 1976 through 1981 and their associated parameters (millions of pounds, number of transactions and number of months) are tabulated on pages 31 and 32 of Report 161. Corresponding data for 1982 are tabulated on page 5 of Report 173.

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CURRENT MARKET DATA

LOAN USE CHARGE RATE[1] 6%
Determined as of December 31, 1983

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

[1] Monthly data for 1968 through 1981 appear on pages 32-34 of Report 162. Monthly data for 1982 appear on page 2 of Report 173.

CONVERSION VALUE[2] $0.60/lb. U as UF_6
Determined as of December 31, 1983

Definition

The Conversion Value is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the last day of the month.

Derivation

Nuexco bases the Conversion Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Conversion Value:

A. The price of conversion services delivered or to be delivered under old contracts.
B. The price of conversion services delivered in connection with contract renegotiations or other than arm's length transactions.
C. Transportation charges other than those customarily provided by primary suppliers of conversion services.

[2] Monthly data for 1981 and 1982 are tabulated on page 6 of Report 173.

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CURRENT MARKET DATA

SWU VALUES

$105/SWU FOR DOE ORIGIN AND FY84 DELIVERY
$85/SWU FOR NON-DOE ORIGIN AND DELIVERY WITHIN 15 MONTHS
Determined as of December 31, 1983

Definition

The SWU (Separative Work Unit) Values represent Nuexco's judgment of the prices, expressed in US dollars per SWU, at which transactions for the sale of significant quantities of SWUs of stated origins could be concluded as of the last day of the month.

Derivation

Nuexco bases the SWU Values upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.
E. SWU prices at varying tails and varying product assays are converted to the equivalent SWU price at the DOE Reference Transaction Tails Assay (presently 0.20 weight percent U_{235}) and a product assay of three percent U_{235} assuming feed costs calculated using the Nuexco Exchange Value and Nuexco Conversion Value determined as of the last day of the same month.

Comments

Nuexco does not consider the following in determining the SWU Values:

A. The price of SWUs delivered under long-term contracts from primary suppliers, such as DOE, Urenco, or Eurodif.
B. The price of SWUs delivered under other than arm's length transactions.

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EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
Australia (dollar)	24.50	54.01	63.69
Belgium (comm. franc)	1,226	2,702	3,186
Canada (dollar)	27.38	60.37	71.19
Finland (markka)	128.21	282.64	333.30
France (franc)	183.49	404.52	477.02
FRG (mark)	59.96	132.19	155.89
Italy (lira)	36,545	80,568	95,008
Japan (yen)	5,106	11,256	13,273
Netherlands (guilder)	67.46	148.73	175.39
South Africa (rand)	26.80	59.08	69.67
Spain (peseta)	3,466	7,642	9,011
Sweden (krona)	176.14	388.32	457.93
Switzerland (franc)	47.98	105.78	124.74
UK (pound)	15.19	33.50	39.50
US (dollar)	22.00	48.50	57.20

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates	per kg. U_3O_8 in Concentrates	per kg U in Concentrates
Australia (dollar)	26.56	58.55	69.05
Belgium (comm. franc)	1,329	2,929	3,454
Canada (dollar)	29.69	65.45	77.18
Finland (markka)	138.99	306.41	361.33
France (franc)	198.92	438.53	517.14
FRG (mark)	65.00	143.31	169.00
Italy (lira)	39,618	87,343	102,998
Japan (yen)	5,535	12,202	14,390
Netherlands (guilder)	73.14	161.24	190.14
South Africa (rand)	29.05	64.04	75.52
Spain (peseta)	3,758	8,284	9,769
Sweden (krona)	190.95	420.98	496.43
Switzerland (franc)	52.02	114.68	135.23
UK (pound)	16.47	36.31	42.82
US (dollar)	23.85	52.58	62.00

[1] Calculated using currency exchange rates published in the Wall Street Journal on December 30, 1983.

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CURRENT MARKET DATA

CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U as UF_6	per kg U as UF_6
Australia (dollar)	0.67	1.47
Belgium (comm. franc)	33.43	73.69
Canada (dollar)	0.75	1.65
Finland (markka)	3.50	7.71
France (franc)	5.00	11.03
FRG (mark)	1.64	3.61
Italy (lira)	996.68	2,197
Japan (yen)	139.24	306.98
Netherlands (guilder)	1.84	4.06
South Africa (rand)	0.73	1.61
Spain (peseta)	94.53	208.41
Sweden (krona)	4.80	10.59
Switzerland (franc)	1.31	2.89
UK (pound)	0.41	0.91
US (dollar)	0.60	1.32

SWU VALUES EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU FY84	Non-DOE SWU delivery w/in 15 mo.
Australia (dollar)	116.93	94.65
Belgium (comm. franc)	5,850	4,735
Canada (dollar)	130.69	105.80
Finland (markka)	611.89	495.34
France (franc)	875.73	708.92
FRG (mark)	286.18	231.67
Italy (lira)	174,419	141,196
Japan (yen)	24,368	19,726
Netherlands (guilder)	321.99	260.66
South Africa (rand)	127.89	103.53
Spain (peseta)	16,543	13,392
Sweden (krona)	840.67	680.54
Switzerland (franc)	229.01	185.39
UK (pound)	72.51	58.70
US (dollar)	105.00	85.00

[1] Calculated using currency exchange rates published in the Wall Street Journal on December 30, 1983.

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RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
2619	1985	301-600	109	European Entity	European Utility	Assumes $95 per SWU and $0.60 per lb. U for conversion.
2620	1984	301-600	indeterminate	unknown	US Utility	Price related to market.

Loan Transactions

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current L.U.C.R.	Lender	Borrower	Remarks
2607	1983	50-100	108	US Utility	US Producer	
2624	1984	301-600	92	US Utility	US Producer	

Secondary Market Conversion Services

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U equivalent)	Approximate Price as Percent of Current C.V.	Seller	Buyer	Remarks
2617	1984	50-100	154	US Utility	European Utility	

Secondary Market Enrichment Services

Nuexco Transaction Number	Delivery Period[2]	Approximate Quantity (thousands of SWUs)	Approximate Price[3] as Percent of Current SWU Value[4]	Tails Assay (Percent U_{235})	Seller Group	Buyer Group	SWU Origin	Remarks
2597	1985	50-100	106	to be determined	European Entity	European Utility	Eurodif	
2634	1989	50-100	113	to be determined	European Utility	European Utility	Eurodif	
2635	1985	less than 50	indeterminate	to be determined	US Utility	European Utility	DOE	FY85 AFC price less a discount.
2636	1986	101-300	106	.2	European Entity	US Utility	Eurodif	Swap for U_3O_8 instead of UF_6.

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[1] Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.

[2] Refers to calendar year, not fiscal year.

[3] Price is not normalized to 0.20% tails assay.

[4] Refers to SWU Value for same origin as SWUs included in transaction.

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CURRENT MARKET DATA

URANIUM SUPPLY
(As of 12/31/83)

	Delivery Period[1] (Thousands of Pounds U_3O_8)		
Nuexco Project Number	**Spot or Near-term[2]**	**Intermediate or Long-term**	**Remarks**
Available for Sale:			
ACTIVE			
1575	—	500 per year	1985-92
1818	—	500 per year	1984-90
2038	2,000	—	UF_6
2134	—	250 per year	1984-87
2201	300	—	
2203	1,000	—	
2220	150	—	UF_6
2235	—	150 per year	1985-89
2236	—	200 per year	1985-89
2263	—	500 per year	1985-90
2274	—	600 per year	1985-91
2275 A	110	—	
2297	60	200 per year	1985-89
2307	340	—	UF_6
2315	170	950	UF_6
2335	200	—	
2336	250	250 per year	1985 on
2365	20	—	
2366	600	—	
2376	200	—	U_3O_8 or UF_6
2429	450	—	
TOTAL:	5,930		
INACTIVE			
2017	1,100	1,200	
2271	—	500 per year	1984-85
2191	125	—	UF_6
2193	—	800 per year	1986-90
2309	950	—	
TOTAL:	2,175		

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[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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URANIUM DEMAND
(As of 12/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
1459	—	200 per year	1988 on
2025	420	350	
2167	250	250 per year	1984-89
2233	700	—	U_3O_8 or UF_6
2304	—	500 per year	1987 on
2310	800	—	enriched UF_6
2313	260	255	1985
2329	—	500	1985
2372	—	250 per year	1985-88
2413	—	250 per year	1986-88
2416	—	430	
2419	50	—	
TOTAL:	2,480		
INACTIVE			
1999	—	50 per year	1985-90
2118 A	250	—	
2244	—	350 per year	1985 on
2302	—	250 per year	1987 on
2360	270	—	enriched UF_6
2371	—	260 per year	1984-90 UF_6
2414	—	100 per year	1987-91 U_3O_8 or UF_6
TOTAL:	520		

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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CURRENT MARKET DATA

LOAN SUPPLY AND DEMAND
(As of 12/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Within 1 Year	Beyond 1 Year	Remarks
Available for Loan: ACTIVE			
1815	1,000	—	UF_6
1938	1,500	—	UF_6
2128	1,000	—	
TOTAL:	3,500		
INACTIVE			
1884	600	—	
2036	500	—	UF_6
2139	2,000	—	
TOTAL:	3,100		
Inquiries to Borrow: INACTIVE			
2118	250	—	U_3O_8 or UF_6
TOTAL:	250		

[1] Measured from the date of this Report.
[2] Available within one year.

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CONVERSION SUPPLY
(As of 12/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF₆)		Remarks
	Within 3 Years	Beyond 3 Years	
ACTIVE			
2051	1,500	—	
2141	1,500	—	
2143	200	—	
2220	210	—	
TOTAL:	3,410		
INACTIVE			
1609	1,500	—	
1936	1,500	—	
2181	1,300	650 per year	1985-90
2230	300	—	
2401	600	—	
TOTAL:	5,200		

CONVERSION DEMAND
(As of 12/31/83)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF₆)		Remarks
	Within 3 Years	Beyond 3 Years	
ACTIVE			
2380	700	—	
2386	330	—	
2420	300	—	
TOTAL:	1,330		
INACTIVE			
2194	—	300 per year	1986 on
2287	—	250 per year	1986 on
2295	200	—	
TOTAL:	200		

[1] Measured from the date of this Report.

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CURRENT MARKET DATA

SWU SUPPLY AND DEMAND
(As of 12/31/83)

	Delivery Period[1] (Thousands of SWUs)		
Nuexco Project Number	**Spot or Near-term[2]**	**Intermediate or Long-Term[3]**	**Remarks**
Available for Sale:			
ACTIVE			
1859	—	1,000	
2100	—	100	
2164	120	—	
2189	85	80	1985
2192	—	325	
2210	—	70	1985
2285	500	3,000	
2345	—	500	1985
2351	—	150 per year	1985-91
2359	180	—	
2378	—	120 per year	1985-89
2408	—	120	1985
2428	—	200	1985
TOTAL:	885		
INACTIVE			
2137	80	80 per year	1985 on
2337	250	250	
2375	200	—	
TOTAL:	530		
Inquiries to Purchase:			
ACTIVE			
2233	250	—	
2310	200	—	
2346	—	100 per year	1985-89
2355	—	180 per year	1986,88,90,92
2362	150	—	
2400	—	85	1985
2410	20	85	1985
2412	—	80	1985
TOTAL:	620		
INACTIVE			
2237	—	250 per year	1985 on
2418	—	100	1987

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[1] Measured from the date of this Report.
[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.
[3] For delivery beyond one year.

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CANADA

On October 20, 1983 the first drum of yellowcake was packaged at the Key Lake mill and by the end of November, 700 thousand pounds U_3O_8 had been produced. According to a Saskatchewan Mining Development Co. (SMDC) news release, the design capacity of 1 million pounds U_3O_8 per month from Key Lake should be reached early this year.

* * *

SERU Nucleaire (Canada) released information about a major new discovery located in the Athabasca Basin region of Northeastern Saskatchewan. The area is referred to as the Waterbury uranium deposit or Cigar Lake. During 1983, 65 holes were drilled on the primary structure. All the holes reportedly intersected the orebody, and results from some of the more remarkable holes reported are shown in Table 2.

Table 2

WATERBURY DEPOSIT DRILLING RESULTS

Hole length (meters)	Average Grade (percent U_3O_8)
3.25	10.78
6.50	19.11
9.50	25.02
13.00	11.44
14.16	7.20
15.00	13.53
17.00	24.08

The Waterbury joint venture group consists of SERU Nucleaire (33.61 percent), SMDC (50.75 percent), Idemitsu Uranium Exploration Canada (11.88 percent), and Reserve Oil and Minerals (2.75 percent). SERU Nucleaire is the operator. Announced reserves are 125 million pounds, and average grade is rumored to be 5 percent or better. Commercial development of the deposit probably will commence early in the 1990s.

* * *

At its convention in early December, the Saskatchewan New Democratic Party (NDP) voted in favor of phasing out uranium mining in the province. Ironically, the NDP once championed the expansion of the uranium industry in Saskatchewan. (It was the ruling party when SMDC was formed in part to develop uranium deposits such as Key Lake.) The NDP vote has not caused much alarm in Canadian mining circles, as the party is not likely to regain power in the near future.

ITALY

In November ENEL (Ente Nationale Per L'Energia Electrica), Italy's state utility, announced an electricity program to 1995 that includes substantial increases in nuclear power development. The plan calls for oil-fired plants' share of electricity generation to decrease from the present 50 percent to 20 percent, while coal generation will grow from 13 to 31 percent and the nuclear share will rise from 3 to 20 percent, as shown in Table 3.

Table 3

ENEL ELECTRICITY SOURCE PLAN TO 1995

Source	1983 Share	1995 Share
Oil	50	20
Coal	13	31
Nuclear	3	20
Other	34	29

Currently Italy has only three operational reactors, having a cumulative net generating capacity of 1,237 MWe. The ENEL plan shows a growth in nuclear generating capacity to almost 12,000 MWe. The two Montalto units currently under construction, which should be completed near the end of the decade, will add approximately 2,000 MWe to the total. The other 9,000 MWe of nuclear orders is in the planning stage. ENEL has faced difficulty in the past getting approval of reactor sites. Government iniatives over the past year aimed at providing incentives to regions that accept reactor sites have given rise to some optimism that plant approval will be streamlined.

UNITED STATES

During the past month three utilities announced that new units had reached or were close to commercial operation. South Carolina Electric and Gas announced on January 1 that Summer 1, its first unit, had achieved commercial operation. Pacific Gas and Electric completed fuel loading at Diablo Canyon 1 and hopes to have the unit operating commercially by May. Washington Public Power Supply Service received a fuel loading and low power testing license for WNP 2 (a BWR), which it hopes will be operating commercially by July of this year.

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ANALYSIS & COMMENTARY

THE US FEDERAL ENERGY REGULATORY COMMISSION (PART 2)

Introduction

This is the second in a series of articles examining facets of the regulatory environment in which nuclear utilities operate. Report 182 (October 1983) discusses the organization of the US Federal Energy Regulatory Commission (FERC), which is the most prominent federal regulatory body having jurisdiction over electric utilities. FERC's regulatory power actually manifests itself much more by influence than by direct regulation. The Commission's jurisdiction is limited principally to wholesale electric power transactions, defined as sales for resale. Thus, sales of electricity from an electric utility to another or to a municipality or rural cooperative fall under FERC jurisdiction. It also includes all wheeling transactions. FERC reports that all transactions under its jurisdiction account for only 5 percent of US electric utility transactions. All the rest come under state and local jurisdiction. FERC's influence comes from its working relationship with most of the state and local public utility commissions (PUCs). PUCs tend to follow FERC's lead in matters of regulation, so a FERC ruling affects much more than the 5 percent of transactions under its direct regulation.

Accounting Standards

FERC has established and enforces a Uniform System of Accounts, which contains accounting rules and procedures for the electric utility industry. Utilities must use this accounting system for all wholesale transactions. PUCs frequently use the uniform system in establishing their own accounting rules, just as many states use the federal Uniform Commercial Code in establishing their own state commercial codes. Investor-owned utilities must use FERC's Uniform System of Accounts in all stockholder reporting. As noted in Report 182, the Uniform Sysem of Accounts specifies the rules and procedures used for accounting for nuclear fuel, including related fuel cycle services.

Proposed Rule Change

Currently FERC is revising the guidelines for the accounts concerned with expenditures at the front end of the nuclear fuel cycle. A proposed rule, which is in the process of refinement, would distinguish between expenditures that are eligible and ineligible for allowances for funds used during construction (AFUDC).

AFUDC is the accounting procedure used to capitalize net composite interest and equity costs of capital funds used to finance construction (construction work in progress, or CWIP). In the same manner as construction, labor and materials costs, AFUDC is a non-cash, non-operating item and is recognized as a cost of "Electric Plant" with offsetting credits to "Other Income" and "Interest Deductions." AFUDC permits a utility to recover some capital costs through inclusion in the rate base and in the provisions for depreciation. Under current rules nuclear fuel (including U_3O_8, UF_6, enriched UF_6 and fabricated assemblies) prior to reactor loading can be included in CWIP and is therefore eligible for AFUDC.

FERC's proposed rule change affects a number of items, including:

1. advances made to DOE for enrichment services long before processing of materials is undertaken;
2. advance payments for future yellowcake deliveries that are based on estimates of requirements which proved wrong; (Payments to be addressed may include acquisition of ownership interest in mine and processing facilities, as well as advance payments under supply contracts.)
3. stockpiled nuclear materials obtained in advance of need for use in fabricating fuel assemblies;
4. disposition of gains or losses from the sale of nuclear fuel included in stock accounts.

The thrust of the proposed rule is to limit utilities from taking AFUDCs on "abnormally large inventories" of nuclear fuel that have accumulated as a result of reactor deferrals, cancellations, and other factors. The key to FERC's proposal will be the definition of abnormally large inventories and the distinction between nuclear fuel that is in the process of refinement and that which is just sitting in inventory.

Any new rules made by FERC will only be directly applicable to transactions over which FERC has authority. However, because FERC's influence is widespread, local PUCs are following the development of this rule closely. The proposed rule is scheduled to be released during the first quarter of this year.

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US DOE GASEOUS DIFFUSION PLANTS

Introduction

The US Department of Energy (DOE) operates three gaseous diffusion plants (GDPs) for the enrichment of uranium used in commercial nuclear reactors. The Oak Ridge GDP in Oak Ridge, Tennessee, was completed by the US Army Corps of Engineers in 1945 as part of the US government's Manhattan Project (Figure 2). The original Oak Ridge facility contained a complete cascade, meaning that the plant was capable of enriching feed for military purposes to greater than 97 weight percent (w/o) U_{235}. The Paducah GDP in Paducah, Kentucky was constructed over a four-year period ending in 1954, and the Portsmouth GDP in Portsmouth, Ohio was completed in 1955.

Overview of Facilities

Gaseous diffusion enrichment is accomplished by passing UF_6 feed through a series of stages that gradually separate enriched UF_6 from depleted UF_6 (see Report 184 for a survey of the enrichment process). Each stage contains a diffuser vessel, a gas compressor for the feed line, a drive motor, a control valve and associated piping. A heat exchanger controls the stage temperature. The diffuser vessel contains the porous tube barrier through which enriched product is drawn; the separation efficiency of each stage is a function of the size of the holes in the barrier. Eight to ten stages comprise a cell (Figures 3 and 4), and at DOE's facilities UF_6 feed is passed through a number of interconnected cells located in several process buildings.

Two types of compressors, axial flow and centrifugal compressors, are required to compress UF_6 gas to the pressures necessary to cause flow through the barriers and between stages. The large electric motors which drive the gas compressors are rated at 3300 horsepower each. To indicate the scale of these large stage components, a single SWU involves circulation through a single stage of over 640 thousand kgs of UF_6.[1]

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[1] "United States Gaseous Diffusion Program for Uranium Enrichment", UCC-ND 1982. US Government Printing Office: 1982-546-067/32.

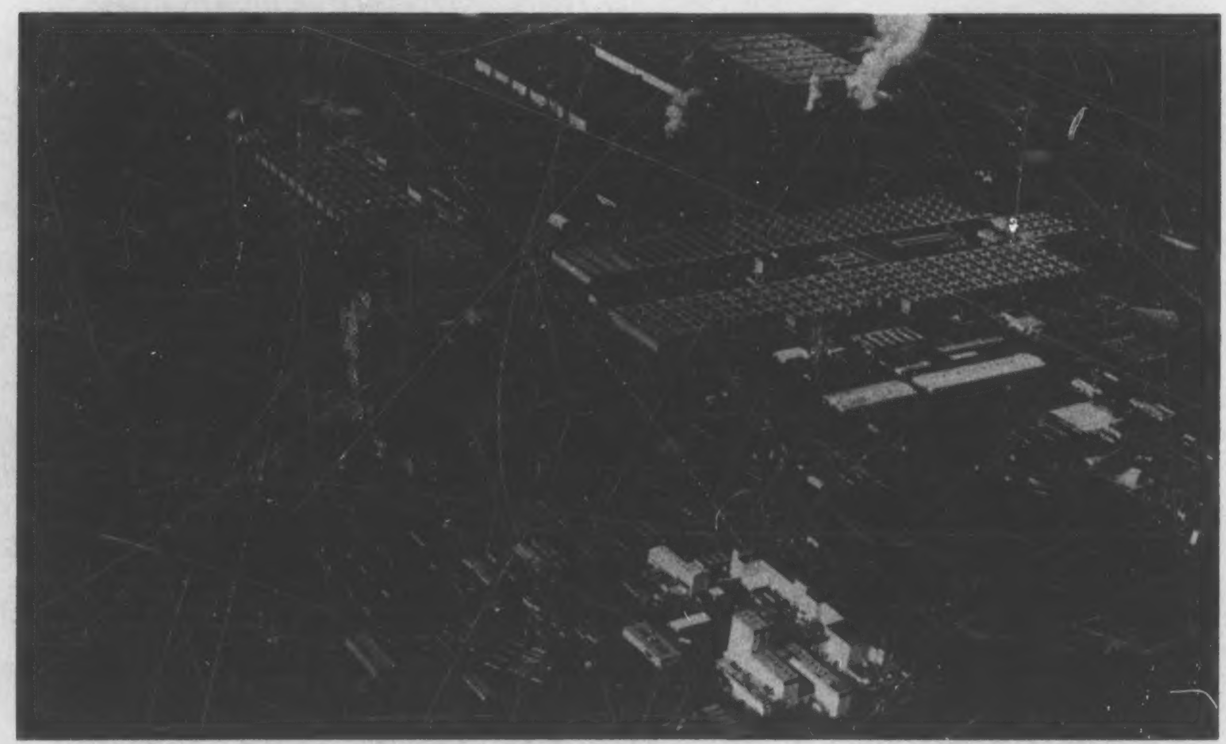

Figure 2. Aerial view of Oak Ridge GDP.

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BASIC CONSIDERATIONS

The control valves are used to optimize gas flow between stages, and large isolation valves are used to isolate a cell from the remainder of the equipment should maintenance be required on any stage. In addition to the equipment required in the diffusion process itself, each plant has extensive feed and withdrawal gas handling systems, electrical power distribution systems and cooling towers to remove the waste heat.

Originally the Oak Ridge GDP had five process buildings. The first building constructed (code named K-25 in the Manhattan Project) has been shut down and cannibalized. It contained the smallest sized stages. The K-27 building, housing the next smallest stages, is now used only as a purge cascade. Without these two buildings in the process, the Oak Ridge GDP is no longer a complete cascade. The three remaining process buildings contain 1,540 stages.

The Paducah GDP has four operating process buildings containing 1,812 stages, including the two biggest stages DOE operates. Portsmouth is the largest plant with 4,080 operating stages. Currently Portsmouth contains the only complete cascade, and thus it is the only GDP capable of producing highly enriched uranium.

DOE integrates the use of the three GDPs according to the need for use of five different stage sizes. Because Paducah only operates two lower stage sizes, uranium is enriched there to approximately 2.0 w/o. Low enriched product then is shipped either to customers or to one of the other two plants. The Oak Ridge GDP uses three stage sizes and enriches to approximately 4.0 w/o.

Operating the plants as an integrated complex allows optimization of power and feed usage and adjustment of product and waste streams (Figure 5). The capacity of the integrated system is approximately 1 percent greater than what would be attainable by operating the three plants separately.

Capacity Expansion Programs

In the early 1970s installed nuclear capacity projections forecasted rapid increases in nuclear power use, and based on those projections the Atomic Energy Commission (AEC), DOE's predecessor, made plans to expand enrichment capacity. Congress granted approval for two expansion programs that would add 10.1 million SWUs annually to the GDPs' capacities. The two expansion programs, which increased capacity from 17.2 million to 27.3 million SWUs per year, were carried out concurrently and completed in 1982.

The Cascade Improvement Program (CIP) increased enrichment capacity by improving the efficiency of the process equipment. Based on 20 years of research and development since the original plants were built, CIP entailed the following modifications:

1. installment of new, more efficient barriers in over 3,100 diffusers;
2. reconstruction of approximately 4,000 compressors with more efficient blading and ducting;
3. improvement of diffuser configurations;
4. installment of low-loss control valves.

These modifications increased the efficiency of power usage in the plants by 32 percent, or 5.5 million SWUs annually.

The Cascade Uprating Program (CUP) added enrichment capacity by increasing power capability (and thus plant throughput) from 6.07 GWe to 7.38 GWe, or 4.6 million SWUs annually. CUP required modifications to both the process equipment and the plant auxiliary systems. Uprating the auxiliary systems allowed for additional power supplies and provided for the disposition of additional process heat. Modifications to the process

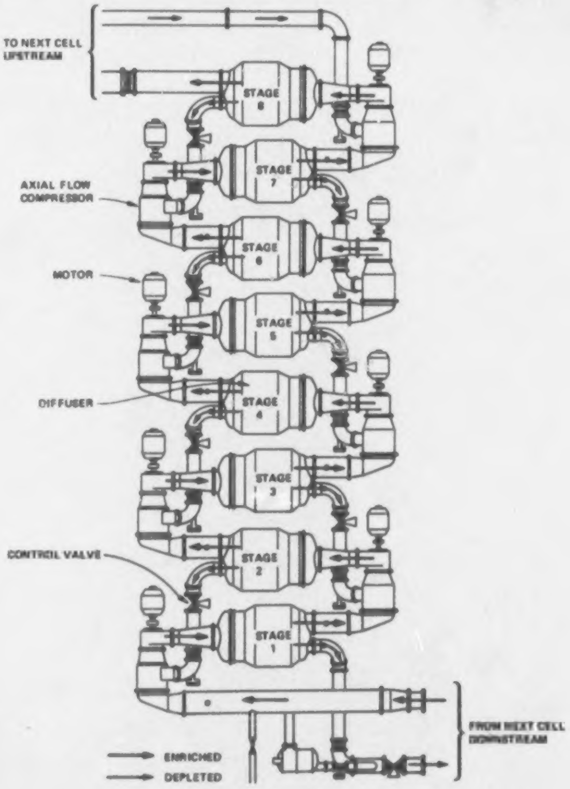

Figure 3

SCHEMATIC OF GASEOUS DIFFUSION CELL

equipment included:

1. uprating approximately 3,800 gas compressors;
2. rebuilding over 3,000 electrical motors;
3. improving mechanical integrity of some stage components;
4. providing for increased stage heat removal at higher energy levels.

Feed and Enriched Uranium Handling

Normally a convertor assumes the responsibility for delivering acceptable UF_6 feed to the enrichment plants. Periodically DOE specifies how the feed should be divided among the three GDPs. As of November 14, 1983 Paducah accepts 45 percent, Oak Ridge takes 30 percent, and Portsmouth 25 percent.

Upon delivery cylinders are checked for air leakage and weighed. Once a cylinder is determined to be safe and its weight has been recorded, it is heated in an autoclave and two samples are taken. One sample is analyzed to determine if the feed is of acceptable quality. The second sample is held in reserve in case a dispute arises later. If the contents of the cylinder are acceptable, the cylinder is queued for feed into the enrichment process on a first-come, first-fed basis. After contents are fed an empty cylinder is weighted to determine the amount of UF_6 delivered by the customer (gross weight - empty weight). Cylinders are not actually empty at this point, but contain some residual UF_6.

One of the advantages of the gaseous diffusion process is the large number of points from which enriched product can be drawn off. Product cylinders can be filled directly from the cascade at very close to the desired enrichment level. If this were not possible, a blending operation would be required to produce the correct product assay. As is, withdrawal of product is similar to delivery of feed.

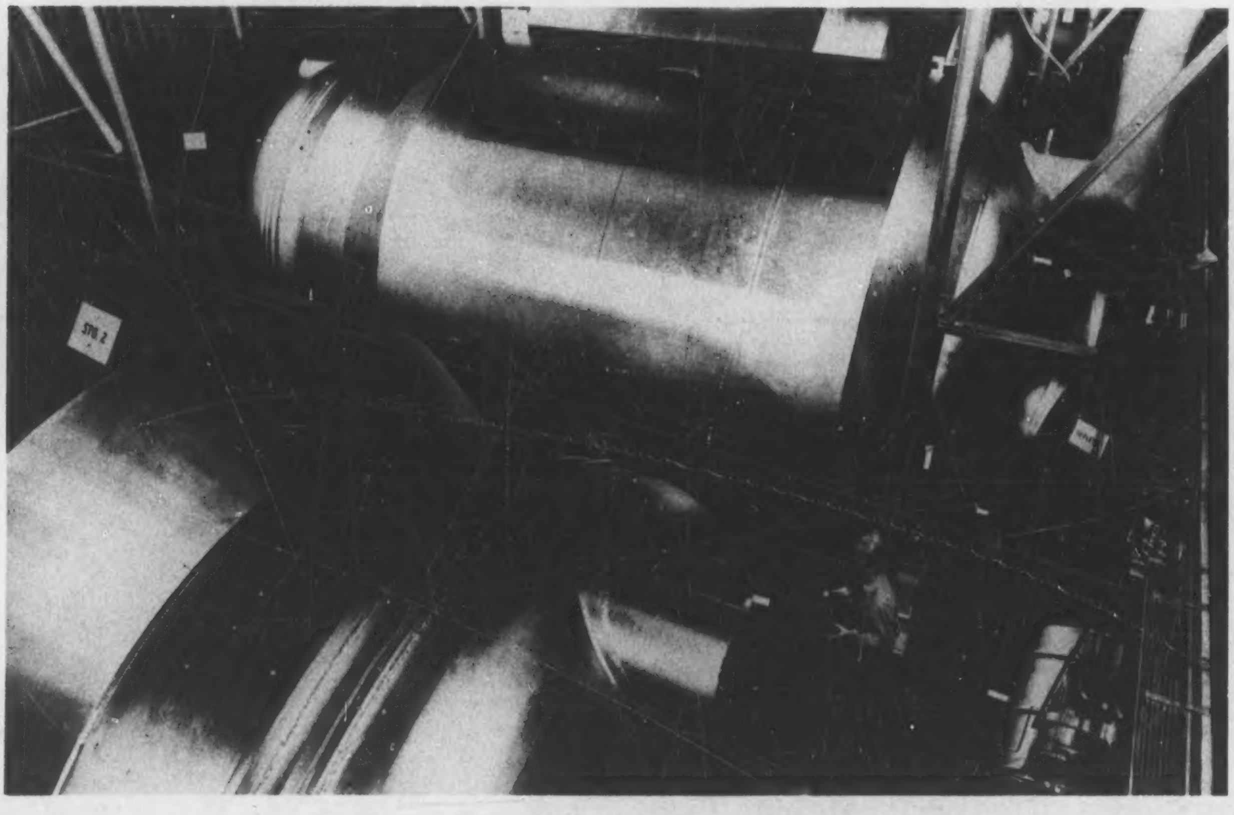

Figure 4. Diffuser vessels with corresponding stage labels.

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BASIC CONSIDERATIONS

The fabricator is usually responsible for providing product cylinders to DOE (cylinder sizes 30A or 30B) at least 30 days prior to the scheduled date of enriched product delivery. Loaded cylinders are taken to the feed receipt and product delivery facility and reheated so that two samples may be taken. Again, the first sample is for immediate analysis and the second is for retention. The final analysis of enriched product determines the amount of enrichment services and the actual amount of feed for a transaction. Product cylinders are picked up by the fabricator for shipment to the fabrication facility.

Inventory

DOE has held large inventories of natural and enriched UF_6 for a number of years. At the end of FY82, DOE had in inventory the equivalent in enriched product of approximately 26 million SWUs and 47 million kgU of DOE-owned and customer-owned UF_6 feed. At that time, there were also some 260 million kgUs of depleted UF_6 in inventory. DOE plans to maintain a minimum SWU inventory of one quarter of the following year's demand. Over the next ten years, DOE projects demand to range from 20 to 30 million SWUs. Enriched inventory has been scheduled to decrease to the equivalent of approximately 9 million SWUs in FY86. However, because of market conditions and production level requirements the scheduled inventory reductions will be difficult to achieve.

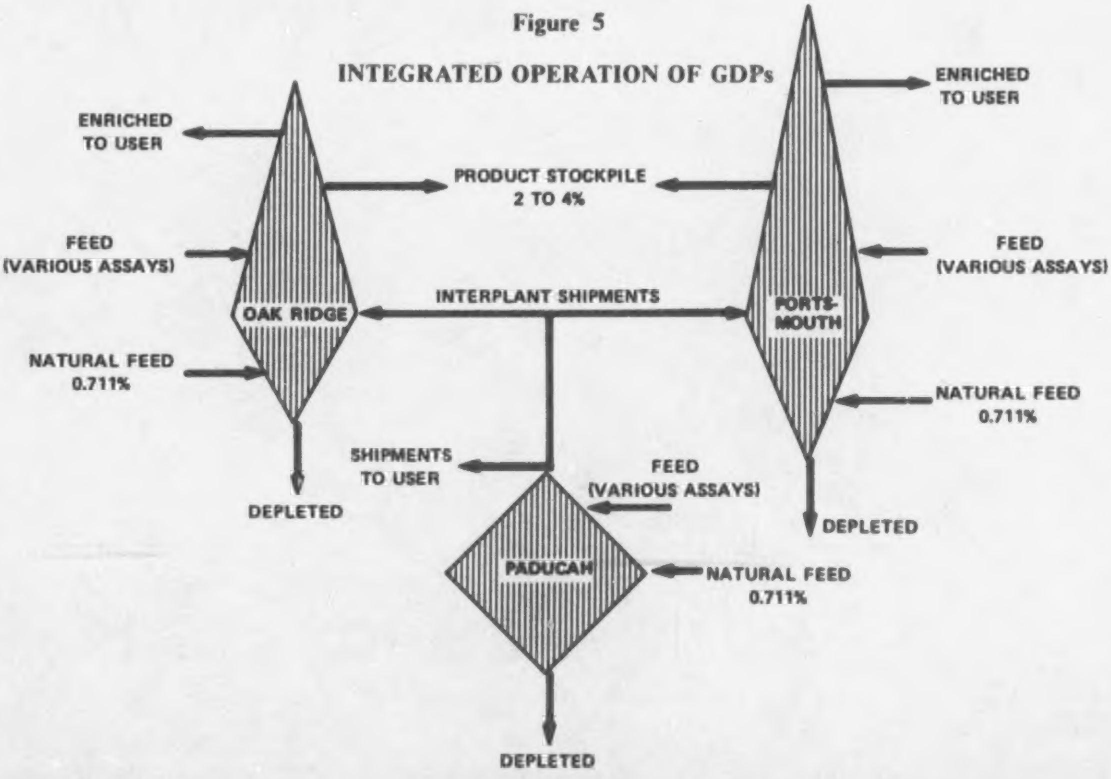
Power Supply

DOE contracts with three utilities for electricity to run its enrichment facilities: Tennessee Valley Authority (TVA) for Oak Ridge and Paduca, Electric Energy Inc. (EEI) for Paducah, and Ohio Valley Electric Corp. (OVEC) for Portsmouth. Combined, the three plants are contracted to take approximately 5 GWe for 1984 operations at a cost close to $1.5 billion.

TVA will supply approximately 70 percent of the total. Recently TVA has come under attack for refusing to allow DOE to renegotiate power contracts that force DOE to pay large penalties for power not taken. DOE estimates that power not taken will exceed 50 percent of the TVA supply contract for 1984. TVA has large electricity surpluses and argues that renegotiation of the gigantic DOE contract will unfairly pass on price increases to TVA's other customers. The cost of power not taken is a major obstacle to DOE's efforts to scale back SWU production.

Figure 5

INTEGRATED OPERATION OF GDPs


ENRICHED TO USER
PRODUCT STOCKPILE 2 TO 4%
ENRICHED TO USER
FEED (VARIOUS ASSAYS)
FEED (VARIOUS ASSAYS)
INTERPLANT SHIPMENTS
OAK RIDGE
PORTSMOUTH
NATURAL FEED 0.711%
NATURAL FEED 0.711%
SHIPMENTS TO USER
FEED (VARIOUS ASSAYS)
DEPLETED
DEPLETED
PADUCAH
NATURAL FEED 0.711%
DEPLETED

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NUCLEAR POWER IN THE UNITED KINGDOM

Introduction

In the early 1950s, the United Kingdom's Atomic Energy Authority (UKAEA) pioneered the development of gas-cooled nuclear reactors (GCRs) that use natural uranium for fuel. Several GCRs were built for commercial electricity generation through the 1960s and are still operating (Table 4), but the design became outdated as larger thermal power plants grew more common and economical. Domestic nuclear research led to the development of advanced gas-cooled reactors (AGRs) with greater capacities than earlier GCRs. Beginning in the late 1960s several AGR orders were placed, but this second generation of nuclear stations in the UK suffered numerous setbacks during the 1970s. Currently only five AGRs are operating commercially, while nine are under construction.

During the past several years alternatives to the AGR have been studied for use in a third generation of nuclear stations. Early in 1981 the Central Electricity Generating Board (CEGB) announced a plan for construction of a PWR at the Sizewell plant in Suffolk. A public inquiry into the Sizewell plan, which the government called for in mid-1981, is still underway. The proposed unit is the center of a national debate over the future of nuclear power in the UK. Moreover, the future of Britain's nuclear power program remains indefinite until the Sizewell inquiry is complete.

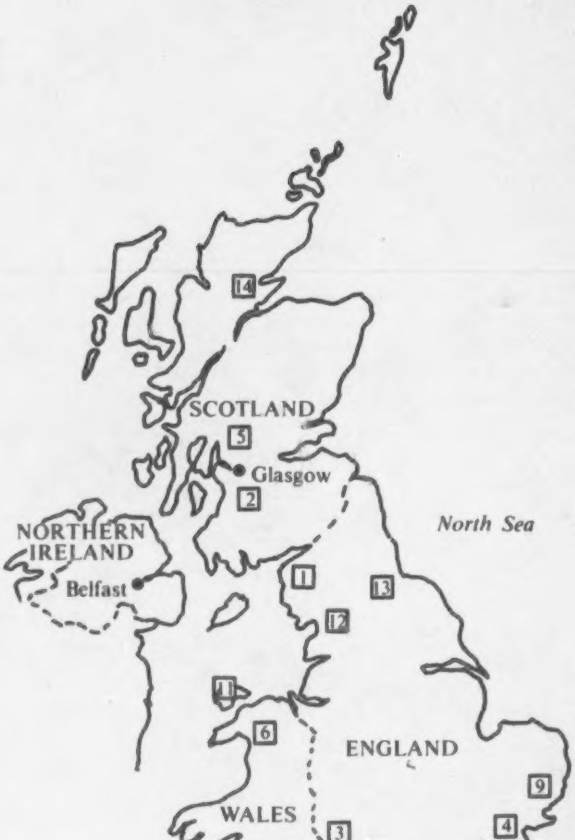
Development of the Gas-Cooled Reactor

In the mid-1950s the UKAEA pioneered the use of carbon dioxide gas as a coolant in the four small (50 MWe each) Calder Hall GCRs built in northern England and the four Chapel Cross reactors in Scotland. Those units were designed to use natural uranium for fuel, as enriched uranium was not yet a commercial commodity. All eight units are operated commercially today by state-owned British Nuclear Fuels Ltd. (BNFL).

Based on the early promise of the GCR, the two primary nuclear utilities in the UK, CEGB and the South of Scotland Electricity Board (SSEB), ordered a series of units for commercial use. Those units, all completed in the 1960s, were designed and constructed by consortiums of British equipment manufacturers; BNFL supplied their fuel. Two units were built at each of nine stations, known as Magnox stations (Table 4). Overall the GCRs have functioned well, and refurbishment of some has prolonged their commercial lives beyond the 25-30 years originally anticipated.

Figure 6

REACTOR SITES IN THE UK



☐ **Reactor Sites**

1. Calder Hall
2. Chapel Cross
3. Berkeley
4. Bradwell
5. Hunterston
6. Trawsfynydd
7. Hinkley Point
8. Dungeness
9. Sizewell
10. Oldbury
11. Wylfa
12. Heysham
13. Hartlepool
14. Torness Point

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FOCUS

Advanced Gas-Cooled Reactors

The early GCRs were limited by their size. By the mid-1960s large coal-fired stations having improved thermodynamic efficiencies made new small reactors uneconomical. Nuclear Power Company Ltd. developed an AGR that used enriched uranium and could operate at a capacity exceeding 600 MWe. Together CEGB and SSEB ordered ten AGRs for five stations in the latter part of the 1960s.

A number of technical, construction and site problems arose in the execution of the AGR program, and to date only five AGRs are operational. The first order placed, for the twin 600 MWe Dungeness reactors, eventually bankrupted the company supplying the units. The Dungeness plant became the focus of difficulties associated with the AGR.

Slowdown of the 1970s

As in other parts of the industrial world, nuclear power development slowed considerably in the early 1970s for several reasons. In an attempt to revive the stalled industry, a design and construction company known as National Nuclear Corporation (NNC) was formed by the government (35 percent ownership), British Nuclear Associates (35 percent), and General Electric of the UK (30 percent). Among other things NNC studied and abandoned a pressure tube reactor, chose an LWR licensor (Westinghouse), carried out a safety study of the PWR, and declared an intention to pursue the PWR. The direction of the UK's nuclear program changed little, however, despite these gestures. In 1979 two orders for new stations were placed—both for AGRs.

Plan for Pressurized Water Reactors

The case for the PWR rested on economy, design uniformity, and the advantages stemming from participation in the mainstream of international nuclear technology. The highly successful French nuclear program, which used standardized US technology, supported this view, as did the West German convoy system.

Under the new Conservative government, the PWR project crystallized in mid-1980 into a proposed 1,110 MWe unit at Sizewell in Suffolk. CEGB applied for planning permission to the Energy Secretary in January 1981. Since the Sizewell plan involved a significant departure from established UK technology, and because of recent international experience such as that at Three Mile Island, Parliament called for a public inquiry in July 1981 to be concluded before the plan could proceed.

Sizewell Inquiry

The Sizewell inquiry was intended to give the public an opportunity to examine all of the issues surrounding nuclear power, and in particular to hear an analysis of:

1. need;
2. economics;
3. safety;
4. waste management;
5. local environmental impact.

In January 1982 the Energy Secretary announced that preliminary hearings for the inquiry would begin within the year but that the main public hearing would not begin in Suffolk until January 1983. The inquiry did commence in January 1983 but seems unlikely to be completed before the summer of 1984. The full responsibility for arguing the case rests with CEGB. Some of the points that are being debated follow.

1. CEGB's current overcapacity is 28 percent, so there appears to be no near-term need for the planned unit. Critics assert that given current scheduling Sizewell would be operational several years before any real demand had arisen. Proponents argue the benefits of phasing out older fossil fuel generation plants.

2. Advocates of nuclear power in general cite the advantages of reducing single source dependency on coal. The Sizewell unit by itself could replace only three percent of the coal-generated capacity CEGB now uses, but a comprehensive PWR program would be a practical means of electricity source diversification.

3. CEGB has argued that the PWR will produce electricity at lower costs to users, in part because of continually rising coal costs. Critics claim that if the future costs of coal are not as high as predicted, and if unforeseen delays, construction overruns and forecast errors are considered, the cost advantage of the PWR could be nullified.

4. Because of the UK's stringent plant safety requirements, the unit would be 20 percent more expensive to build than the same unit in the USA (Kansas Gas & Electric's Wolf Creek and Union Electric's Callaway units are comparable). Specific sources of cost increases would include up to 5 percent more for extra coolant injection circuits, 5 percent more to reduce radiation exposure to employees and 10 perent more to pay for the use of two turbines rather than one. CEGB's design and safety case for the PWR takes account of both US practices and the codes of practice established by the USNRC, and the procedures and approaches developed internally and by the UK Nuclear Installations Inspectorate.

5. The Sizewell site, which is owned by CEGB and has two existing GCR units, is an ideal location for a new re-

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Table 4

COMMERCIAL NUCLEAR REACTORS IN THE UNITED KINGDOM

Station/Units	MWe net Per Reactor	Type	Operating Entity	Commercial Operation	Percent Complete
Calder Hall 1,2,3,4	50	GCR	BNFL	1956	100
Chapel Cross 1,2,3,4	50	GCR	BNFL	1958	100
Berkeley 1,2	138	GCR	CEGB	1962	100
Bradwell 1,2	150	GCR	CEGB	1962	100
Hunterston A1,2	160	GCR	SSEB	1964	100
Trawsfynydd 1,2	250	GCR	CEGB	1965	100
Hinkley Point 1,2	250	GCR	CEGB	1965	100
Dungeness A1,2	275	GCR	CEGB	1965	100
Sizewell A1,2	290	GCR	CEGB	1966	100
Oldbury 1,2	300	GCR	CEGB	1968	100
Wylfa 1,2	590	GCR	CEGB	1971	100
Hinkley Point B1,2	625	AGR	CEGB	1976	100
Hunterston B1	625	AGR	SSEB	1976	100
Hunterston B2	625	AGR	SSEB	1977	100
Dungeness B1	600	AGR	CEGB	1982	100
Heysham A1,2	625	AGR	CEGB	1984	99
Hartlepool 1,2	625	AGR	CEGB	1984	99
Dungeness B2	600	AGR	CEGB	1985	99
Torness Point 1	660	AGR	SSEB	1988	45
Heysham B1	660	AGR	CEGB	1988	40
Torness Point 2	660	AGR	SSEB	1990	30
Heysham B2	660	AGR	CEGB	1990	25
Sizewell B1	1110	PWR	CEGB	1993	planned

actor. No cooling towers are needed since tunnels to the sea can be used, and no additional electricity transmission lines will be needed.

Current Nuclear Power Plans

Currently the two primary economical options for baseload generating capacity are coal and nuclear power. Approximately 80 percent of the UK's electricity is coal-generated, leaving the nation dependent on the price and availability of one fuel. The need for a better energy balance is generally recognized. Assuming the Sizewell unit is authorized, CEGB plans to begin construction on as many as seven PWRs by 1991—one each year in 1987, 1988 and 1989 and two each year in 1990 and 1991. Sizewell would be the first of a series of PWRs to reduce the nation's reliance on coal.

In the mid-1970s the UKAEA developed, designed and constructed a 250 MWe sodium-cooled fast breeder reactor at Dounreay in Scotland. The breeder reactor is viewed as the ultimate electricity source in the UK, where there is almost no indigenous uranium. Further development of the breeder is being conducted in a framework of European cooperation. Overall, there is an active and sophisticated research and development program in the UK. With internationally known component manufacturers and fuel service companies, the nuclear industry is well-developed.

Uranium Consumption and Supply

Table 5 lists Nuexco's estimate of annual U_3O_8 consumption in the UK for the period 1983-90. The consumption calculation accounts for U_3O_8 used for the operation of a commercial reactor at the time the uranium enters the conversion facility, so first cores are consumed approximately two years before commercial operation commences and reloads are tabulated one year before reactor loading. The steady-state consumption level of approximately 4.4 million pounds U_3O_8 in 1983-85 assumes commercial operation of the Heysham A and Hartlepool AGR stations in mid-1984 and the Dungeness B2 unit in early 1985. Increases in consumption in 1986 and 1988 account for initial cores for reactors starting up later in the decade.

Table 5

UK U_3O_8 CONSUMPTION
(millions of pounds U_3O_8)

1983	1984	1985	1986	1987	1988	1989	1990
4.4	4.4	4.4	6.8	4.5	7.2	5.0	6.4

The British Civil Uranium Procurement Directorate (BCUPD) is responsible for supplying uranium in its natural form. Its five board members include one from BNFL, one from SSEB, and three from CEGB. BCUPD's mandates are administered by the British Civil Uranium Procurement Organization (BCUPO).

Outside of reprocessed material, uranium supplies come primarily from two producers, one in Canada and Rossing in Namibia. In 1983 CEGB signed a contract with Pancontinental Mining Ltd. for 4.3 million pounds U_3O_8 from the Jabiluka deposit in Australia. Future deliveries from Jabiluka depend on permission from the Australian government, which currently is restricting new uranium mining to the Olympic Dam deposit.

The drive to diversify sources is leading BCUPO to seek equity positions in undeveloped uranium deposits. Up to now, BCUPO has participated in joint ventures only as a financing partner. It is also expanding its exploration department. A long-term CEGB goal is to have all uranium requirements supplied from BCUPO projects.

Fuel Cycle Services

BNFL, which operates the largest conversion facility in the Free World, provides for most of the upgrading, manufacture and reprocessing of fuel needed by the domestic nuclear program. During the 1970s, BNFL developed a number of advanced techniques in fuel element manufacture. It also joined UCN of the Netherlands and Uranit of West Germany in the development of Urenco, the centrifuge enrichment consortium. Urenco currently has the capacity to produce 1.1 million SWUs per year. In addition to receiving enrichment services from Urenco, CEGB has an enrichment contract with Techsnabexport of the USSR.

Conclusion

The UK's nuclear power program is at a turning point with the Sizewell inquiry, which is focused on a single unit but has wide implications. Although the present government has tried to remove itself from the inquiry, ultimately the Energy Secretary reserves the authority to approve the unit and the Health and Safety Executive decides whether to grant a construction and operating license. Future uranium needs will be determined by the performance of the nine AGRs that are under construction and by the success of the PWR plan. BCUPO is enacting a comprehensive program to diversify uranium supply sources and to increase the UK's participation in international uranium projects.

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JAPAN'S NUCLEAR POWER INDUSTRY INFRASTRUCTURE

Introduction

Behind Japan's rapidly growing commercial nuclear power industry are well-organized electric utilities and a strong national industrial base. This article is an overview of Japan's utility industry, its approach to nuclear power, and its main industrial partners involved in the production of nuclear-related hardware and services.

Electric Utilities

Prior to World War Two the Japanese government consolidated several hundred small utility enterprises and established a nationwide wholesale utility, the Japan Electric Power and Transmission Company (JEPTC). During the war, nine regional monopolies known as electric power distribution companies were organized to distribute electricity to users. Postwar legislation forced these nine regional monopolies to acquire their present form as integrated shareholder companies (Table 6). Together these nine companies distribute power over most of the country (Figure 7), and their combined generation capacity accounts for approximately 75 percent of Japan's total.

In Table 6 four groups are listed in addition to the nine regional electric power companies.

1. The Electric Power Development Corporation (EPDC) has been compared to the Tennessee Valley Authority (TVA) in the USA. The government organized EPDC in 1952 to develop hydroelectric projects and to build coal-fired generation facilities that would stimulate the domestic coal industry. EPDC sells electricity to the regional private utilities.

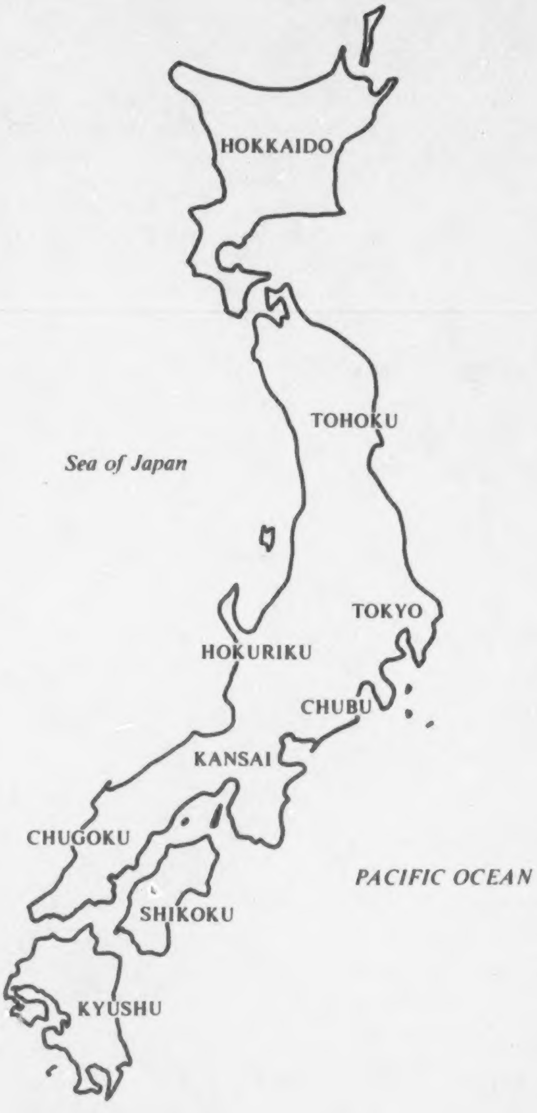
2. Japan Atomic Power Company (JAPC) was organized in 1957 primarily by the nine regional utilities and EPDC for the purpose of pioneering nuclear plant concepts. JAPC also sells electricity to the regional utilities.

3. Other utilities include more than 50 smaller, primarily public enterprises that operate hydroelectric facilities and various joint venture thermal power plants. Most of them wholesale their electricity to the nine regional utilities. Okinawa Electric Power Company, which serves the island of Okinawa, is counted in this category.

4. Industry-owned electrical generation facilities are associated with the operation of industrial facilities such as refineries, steel mills, etc.

Figure 7

REGIONAL COVERAGE OF NINE UTILITIES



As of October 31, 1983, total generation capacity of the nine private utilities, EPDC, JAPC and other utilities totaled 142.1 GWe compared to the 135.6 GWe noted in Table 6. With 24 operational plants, nuclear generating capacity currently amounts to 17.2 GWe. (Report 179 of July 1983 provides an overview of Japan's nuclear generating capacity and uranium supply demand balance.)

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Development of Nuclear-Related Industries

In 1955 the government established the Japan Atomic Energy Commission to oversee the promotion and development of nuclear power. Utilities responded with the creation of JAPC and of nuclear departments internally. The first plans for commercial development came from the two largest utilities, Tokyo Electric Power Company (TEPCO) and Kansai Electric Power Company (Kansai), other utilities followed with later schedules.

Concurrently, Japanese manufacturing concerns organized into five major nuclear groups, based to a degree on historical industrial and financial relations. Most groups consisted of at least one heavy equipment maker, one civil engineering company and related support companies that together would provide the comprehensive engineering and manufacturing expertise needed to undertake a complete nuclear power plant project. Table 6 lists the five industrial groups and the major participants in each one.

Of the five industrial groups, three had non-nuclear electric generation equipment licensing relations with US contractors involved in the then developing US market. Based on those relations, Toshiba of the NAIG group and Hitachi of the TAPIC group entered into agreements in the mid-1960s with General Electric Company (GE) of the USA for a BWR systems license, for nuclear turbine-generator manufacture, and for a license to manufacture nuclear fuel. The fuel agreement led to a joint venture between GE and the Japanese partners to manufacture fuel in Japan. Westinghouse of the USA concurrently concluded similar license agreements with the Mitsubishi group for PWR technology. Those agreements provided the technical basis for the subsequent development of Japan's own LWR technology.

Japanese utilities had initiated programs to construct reactors prior to the license agreements with GE and Westinghouse. Those programs were coordinated efforts designed to give potential licensees and related companies actual experience in hardware manufacture, systems, fuel, and plant construction. The country's first operational reactor was a small 12.5 MWe demonstration BWR supplied by GE and operated in 1963 by the Japan Atomic Energy Research Institute. Toshiba and Hitachi were subcontractors, and Japanese utility personnel participated in the operation of the unit. By 1971, four units were operating commercially, as illustrated in Table 8.

Table 6

PRIMARY SUPPLIERS OF JAPANESE ELECTRICITY[1]

Utility	Customers (millions)	Employees (thousands)	Operating Plants	Capacity (GWe net)
Hokkaido EPC[2]	2.7	6.3	76	3.6
Tohoku EPC	5.6	12.6	221	7.9
Tokyo EPC	18.2	40.1	191	32.9
Chubu EPC	7.3	19.2	185	17.7
Hokuriku EPC	1.5	5.6	118	3.6
Kansai EPC	9.4	24.1	154	23.4
Chugoku EPC	4.1	11.8	108	7.8
Shikoku EPC	2.2	6.6	65	4.8
Kyushu EPC	6.0	14.6	188	10.0
TOTAL Nine Utilities	56.9	140.9	1,306	111.6
Electric Power Development Co.		3.5	54	8.8
Japan Atomic Power Co.		1.1	3	1.6
Other Electric Utilities			285	13.6
TOTAL Other Utilities			342	24.0
Industry-Owned Electricity Generation			781	14.6
TOTAL JAPAN			3,429	150.2

[1] Source: Electrical Industry Survey Institute, 1982.
[2] EPC = Electric Power Company.

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Construction of those four reactors provided Japanese utilities, manufacturers and civil companies with experience upon which to base their future programs. The projects also solidified a network of relations in the nuclear industry. Although General Electric of the UK, Westinghouse, and GE of the USA participated in these initial plants as prime contractors, approximately 65 percent of plant hardware was fabricated by the Japanese subcontractors. The English GCR has not had a subsequent role in Japan's nuclear power program.

Since 1971 20 reactors have been placed in operation by Japanese utilities. Most of those units have been supplied by the Japanese licensees of the US LWR makers. Aside from some minor importation of components and services, reactor supply has become essentially 100 percent domestic.

Reactor Construction Program

Of the nine regional utilities, all except two, Hokkaido EPC and Hokuriku EPC, have successfully implemented nuclear programs. Presently Hokkaido is seeking licenses for its first two units. Several generalizations characterize the programs of all the nuclear utilities.

1. Each utility has relied solely on one reactor type, either BWR or PWR, for its nuclear program. TEPCO, for example, has seven BWRs operating and six under construction. Kansai has seven PWRs operating, and four under construction or licensing review. Only JAPC, in its role as a new-concept pioneer, is building a PWR in addition to its operating GCR and BWRs. By staying with a single reactor type, the utilities have at times suffered from generic problems common to all units. They have, however, developed a high degree of reliability in their plants and competence in their organizations.

While Japanese BWR and PWR designs are based fundamentally on technology acquired from the US licensors, some modifications have been requisite. For example, plant configurations must accommodate Japan's unique seismic conditions. Utilities' desires for better maintenance access and the government's stringent limits on worker radiation exposure levels have also been accommodated.

2. One of the three main domestic reactor suppliers, Toshiba (BWR), Hitachi (BWR), and Mitsubishi (PWR), with support from companies in its respective industrial group, supplies on a turnkey basis virtually all nuclear and turbine generator hardware and systems for a given plant. Supply includes comprehensive architect-engineering services and licensing support, installation of equipment, related piping and electrical work, and extensive warranty and retrofit service. Exceptions to this rule include:

a. Some BWRs have been built with nuclear steam supply systems supplied by Toshiba, while the turbine generators were supplied by Hitachi, and vice versa.

b. US suppliers and architect-engineering firms have participated when new system designs have been introduced, or when new concepts related to licensing have been implemented. Japanese reactor makers maintain license and technical exchange agreements with overseas engineering companies; both Hitachi and MHI, for example, have agreements with Bechtel of the USA.

c. Supply and installation of waste treatment facilities has been conducted by companies not affiliated with the Japanese suppliers.

Table 7

JAPANESE NUCLEAR INDUSTRIAL GROUPS

Group Name	Hardware/Systems Supply	Civil Engineering	Companies in Group
Mitsubishi	Mitsubishi Heavy Industries Mitsubishi Elec.	Ohbayashi-Gumi Taisei Constr.	27
Tokyo Atomic (TAPIC)	Hitachi Ltd. Babcock-Hitachi	Kajima Corp.	22
Nippon Atomic (NAIG)	Toshiba Corp. Ishikawajima Harima Heavy Industries	Takenaka Komuten Shimuzu Constr.	33
Sumitomo Atomic	Sumitomo Heavy Industries Sumitomo Metals Sumitomo Atomic Power Industries		38
First Atomic (FAPIG)	Fuji Elec. Kawasaki Heavy Industries	Shimuzu Constr.	22

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Table 8
JAPAN'S FIRST FOUR COMMERCIAL REACTORS

Unit and Owner	MWe	Type	Supplier	Japanese Subcontractor	Commercial Operation
Tokai I (JAPC)	166	GCR	GE (UK)	FAPIG	1966
Tsuruga I (JAPC)	357	BWR	GE (USA)	Toshiba Hitachi	1970
Mihama I (Kansai EPC)	340	PWR	Westinghouse	Mitsubishi	1970
Fukushima I (Tokyo EPC)	460	BWR	GE (USA)	Toshiba Hitachi	1971

3. Generally the utilities contract civil work—building design and construction of facilities—to one of the major Japanese construction companies (Kajima, Shimizu, Taisei, Ohbayashi-Gumi, Takenaka). For earlier plants such contracts were arranged on the basis of the civil company's relationship to the maker's group. In recent years there has been some diversity and crossing of group relations, and several joint ventures have occurred among the five main constructors.

The construction companies perform their scope of work on a turnkey basis. Reactor suppliers undertake to coordinate hardware/system licensing and design processes with the construction companies. Utilities maintain responsibility for overall project management.

4. Contracts with nuclear makers and builders normally are negotiated with sole sources for lump sums, precluding competitive bidding. While this contracting method is often criticized outside Japan, contractors in general have performed on schedule and within budget. Final plant costs in Japan are competitive with costs in other countries, and contruction time is far shorter.

Fuel Fabrication

Utilities arrange for fuel fabrication with the three reactor makers—Toshiba, Hitachi and Mitsubishi. Actual fabrication of BWR fuel is performed by Japan Nuclear Fuel (JNF), a joint venture established under an early fuel license agreement between Hitachi/Toshiba and GE. Mitsubishi Nuclear Fuel (MNF) fabricates PWR fuel, in accordance with Mitsubishi's early agreement with Westinghouse. Table 9 lists the fuel fabrication companies and their capacities. Nuclear Fuel Industries (NFI) was organized by members of the Sumitomo and FAPIG groups to fabricate BWR, PWR and test reactor plate fuel.

Conclusion

The current Japanese nuclear generation industry is mature and almost entirely self-sufficient. Of the five industrial groups initially organized to develop Japan's nuclear program, the dominant role has gone to those represented by the three leading reactor makers, Toshiba, Hitachi and Mitsubishi Heavy Industries (MHI). These three organizations are also participants in the national programs sponsored by the Japanese government for development of a Fast Breeder Reactor and of fushion technology. While it still relies on overseas suppliers for fuel cycle services, Japan is also in the process of developing its own conversion, enrichment and reprocessing capabilities. By the turn of the century, uranium supply may be the only element of the commercial nuclear power program for which the Japanese will be dependent on foreign supply.

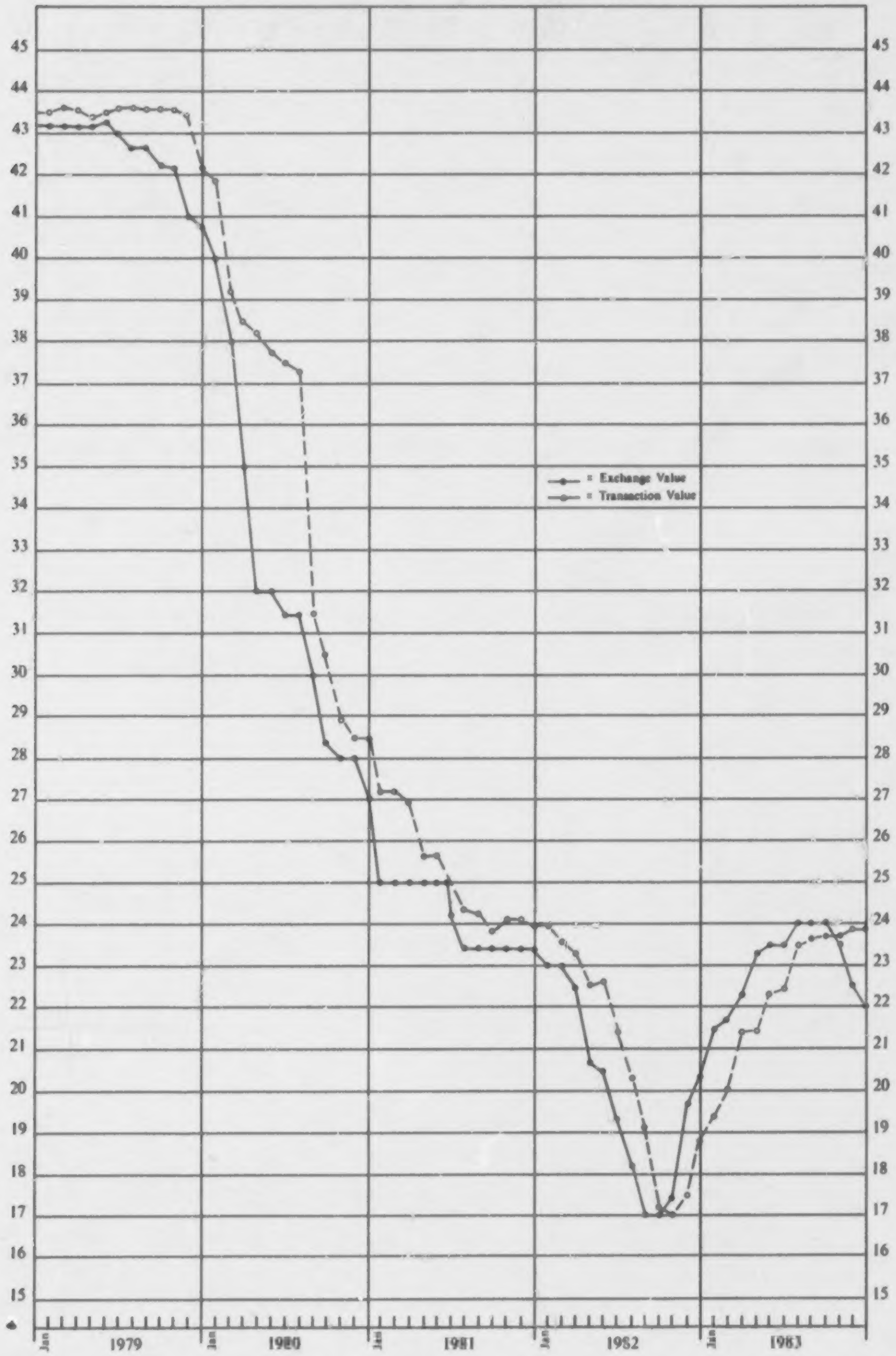
Table 9
JAPANESE NUCLEAR FUEL COMPANIES

Company	Ownership	Fuel Type	Capacity (tons/yr)	Planned Capacity
JNF	Toshiba Hitachi GE	BWR	490	750 by 1985
MNF	Mitsubishi Metals MHI Westinghouse	PWR	420	420
NFI	Furukawa Elec.	BWR	40	100 by 1984
	Sumitomo Elec.	PWR	85	265 by 1984

HISTORICAL MARKET DATA

EXCHANGE AND TRANSACTION VALUES
SINCE JANUARY 1979

Determined as of the last day of the month indicated



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HISTORICAL MARKET DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	**22.00**

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	**23.85**

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	**0.60**

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AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage Earners, Weekly Rates[2] (1976=100)
1972 Avg.	105.6	71.3
1973 Avg.	124.4	79.0
1974 Avg.	141.9	108.1
1975 Avg.	150.4	132.6
1976 Avg.	168.4	160.9
1977 Avg.	192.0	179.0
1978 Avg.[3] [4]	198.5	190.0
1979 Avg.	248.8	127.9
1980 Avg.	321.8	140.8
1981 Avg.	355.3	154.1
1982 Avg.[5]	368.6	174.9
Sep 1982	375.3	178.4
Oct 1982	378.5	178.4
Nov 1982	375.9	178.5
Dec 1982	374.9	179.5
Jan 1983	385.7	179.6
Feb 1983	387.5	179.5
Mar 1983	397.4	179.4
Apr 1983	407.3	179.7
May 1983	414.8	179.8
Jun 1983	415.6	179.9
Jul 1983	408.4	179.5
Aug 1983	403.1R	179.5
Sep 1983	403.1P	179.4
Oct 1983	—	186.4P

P = Preliminary   R = Revised since last month

[1] Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0).

[2] Australian Bureau of Statistics, Canberra: "Award Rates of Pay Indexes, Australia" (Catalogue No. 6312.0). Figures for the latest fourteen months shown are subject to revision.

[3] Monthly data for 1970-78 appear on pages 4.7 and 4.8 of Report 138.

[4] Annual averages prior to 1979 reflect index base no longer in use.

[5] Monthly data for 1979-82 appear on page 35 of Report 184.

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GOVERNMENT STATISTICS

CANADA

		Wage-earner Data: Average Hourly Earnings (C$)[2] [3]				
	Industry Selling Price Index: Manufacturing[1] (1971=100)	**Metal Mining, including Milling[4] (SIC 050-099)**	**Primary Metal Industries (SIC 296)**	**Non-ferrous[5] (SIC 296-298)**	**(SIC 298)**	**Chemicals and Chemical Products[6] (SIC 370-379)**
1979 Avg.[7]	217.9	9.66	—	7.35	—	7.67
1980 Avg.	247.2	10.80	—	8.05	—	8.50
1981 Avg.	288.7	12.23	—	9.03	—	9.53
1982 Avg.[8]	288.8	13.92	—	9.98	—	10.63
Sep 1982	292.4	14.01	—	10.18	—	10.73
Oct 1982	292.1	13.89	—	10.18	—	10.86
Nov 1982	291.3	14.28	—	10.43	—	10.90
Dec 1982	292.3	14.32	—	10.55	—	11.06
Jan 1983	292.7	14.35	—	10.72	—	11.06
Feb 1983	293.5	14.28	—	10.74	—	11.06
Mar 1983	295.2	14.48	—	10.93	—	11.21
Apr 1983	297.1	14.13	11.57	—	10.10	11.02
May 1983	298.5	14.10	11.39	—	9.82	10.97
Jun 1983	299.3	14.07	11.33	—	9.84	11.05
Jul 1983	300.4	13.93	11.70	—	9.83	11.04
Aug 1983	301.2	13.89	11.82	—	10.08	11.19
Sep 1983	309.9R	14.41R	11.99R	—	10.32R	11.19R
Oct 1983	301.4R	14.37P	11.72P	—	10.60P	11.37P
Nov 1983	301.5P	—	—	—	—	—

P = Preliminary R = Revised since last month

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[1] Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (Catalogue 62-011). Indexes for the most recent six months shown are subject to revision.

[2] Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours" (Catalogue 72-002).

[3] Beginning with the April 1983 figure, Wage Earner Data are based on a census of all companies employing 200 or more wage earners, *plus* a random survey of companies employing fewer than 200 wage earners. Prior to April 1983 only companies employing fewer than 200 wage earners are included in the Wage Earner Data.

[4] The wage earner series in Nuexco reports prior to March 1983 was "Metals" (SIC 050-059).

[5] Beginning with the April 1983 figure, Primary Metal Industries, non-ferrous is split into SIC 296 and SIC 298.

[6] Chemical and Chemical Products prior to April 1983 was SIC 370-379. The new series is from a new survey which includes all companies and is based on a 1970 classification. The old survey only included companies of 20 employees or more.

[7] Monthly ISPI for 1977 and 1978 appear on page 4.10 of Report 138, and monthly wage-earner data for 1973-78 appear on page 4.11 of Report 138.

[8] Monthly data for 1979-1982 appear on page 37 of Report 184.

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REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100)	Producer Price Index All Groups[4] (1975=100)[3]	Total Employment in Mining and Quarrying (Code 35)[5]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[5]
1972 Avg.	8.79	113.3	63.9	623,067	443,933
1973 Avg.	10.51	124.1	72.3	684,743	572,133
1974 Avg.	13.18	138.5	85.3	674,140	761,596
1975 Avg.	16.71	157.2	100.0	639,473	1,003,617
1976 Avg.	19.30	174.7	115.1	671,240	1,212,983
1977 Avg.	23.87	194.4	130.0	712,006	1,420,670
1978 Avg.	27.14	137.2	142.7	664,571	1,537,169
1979 Avg.[6]	30.18	155.3	164.5	692,209	1,830,632
1980 Avg.[7]	35.53	176.7	192.1	714,379	2,279,615
1981 Avg.	41.89	206.5	218.3	728,506	2,820,505
1982 Avg.[8]	47.25	233.5	248.7	707,552	3,246,071
Jun 1982	45.77	232.1	246.7	707,552	261,361
Jul 1982	—	234.1	249.4	702,141	283,248
Aug 1982	—	236.8	253.4	705,562	276,730
Sep 1982	48.04	241.0	255.0	704,344	282,782
Oct 1982	—	243.9	260.1	701,316	285,328
Nov 1982	—	245.4	262.5	707,966	287,699
Dec 1982	49.62	246.2	263.0	683,982	288,019
Jan 1983	—	249.0	264.9	688,030	289,075
Feb 1983	—	253.1	267.4	697,089	281,413
Mar 1983	50.35	255.9	269.1	695,976	290,586
Apr 1983	—	257.8	270.9	697,158	286,708
May 1983	—	259.7	274.1	701,712	295,701
Jun 1983	50.51	260.8	273.1	706,933	300,177
Jul 1983	—	262.5	273.7	704,202	314,566
Aug 1983	—	265.6	278.9	698,984	311,789
Sep 1983	52.92	267.3	279.4	—	—
Oct 1983	—	270.0	281.0	—	—
Nov 1983	—	271.4	—	—	—

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[1] Chamber of Mines of South Africa, Johannesburg: "Analysis of Working Results," published quarterly. The tonnage-weight index of average working costs per metric ton of gold ore milled for 1983 follows. (Base: March quarter 1982 = 100). See page 16 of Report 178 for the description and calculation of index, and page 24 of Report 178 for figures for 1982.

1983:		
	January-March	111.2
	April-June	111.9
	July-September	117.4

[2] Republic of South Africa Department of Statistics, Pretoria: "Government Gazette: Consumer Price Index for Urban Areas."

[3] For annual averages prior to 1978, April 1970 = 100.

[4] Previously known as the WHOLESALE PRICE INDEX, now the PRODUCER PRICE INDEX. The computation remains the same.

[5] Bulletin of Statistics, Department of Statistics, Pretoria.

[6] Historical data for the Average Declared Working Costs and Consumer Price Index 1970-1979 appear on page 4.9 of Report 140.

[7] Monthly data for Codes 35 and 40, 1977-1980, appear on page 28 of Report 157.

[8] Monthly data for 1979-82 appear on page 39 of Report 184.

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GOVERNMENT STATISTICS

UNITED STATES

	Producer Price Index[1]		Consumer Price Index[2]	GNP Implicit Price Deflator[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
	Industrial Commodities (1967=100)	All Commodities (1967=100)	(1967=100)	(1972=100)	Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1972 Avg.	117.9	119.1	125.3	100.00	4.56	4.59	4.26	3.71
1973 Avg.	125.9	134.7	133.1	105.75	4.84	4.98	4.51	3.91
1974 Avg.	153.8	160.1	147.7	115.08	5.44	5.63	4.88	4.21
1975 Avg.	171.5	174.9	161.2	125.79	6.13	6.24	5.39	4.64
1976 Avg.	182.4	183.0	170.5	132.34	6.76	6.87	5.91	4.96
1977 Avg.	195.1	194.2	181.5	140.05	7.28	7.67	6.43	5.39
1978 Avg.[5]	209.4	209.3	195.4	150.42	8.23	8.56	7.02	5.82
1979 Avg.	236.5	235.6	217.4	163.42	9.27	9.50	7.60	6.32
1980 Avg.	274.8	268.8	246.8	178.64	10.26	10.63	8.30	6.94
1981 Avg.	304.1	293.4	272.4	195.51	11.55	11.98	9.12	7.62
1982 Avg.[6]	312.3	299.3	289.1	207.15	12.33	12.94	9.96	8.21
Nov 1982	315.0	300.3	293.6	—	12.53	13.22	10.26	8.45
Dec 1982	315.2	300.7	292.4	210.00	12.53	13.05	10.32	8.51
Jan 1983	313.9	299.9	293.1	—	12.63	13.33	10.34	8.53
Feb 1983	313.9	300.9	293.2	—	12.66	13.29	10.41	8.56
Mar 1983	313.5	300.6	293.4	212.83	12.48	13.35	10.39	8.60
Apr 1983	312.4	300.6	295.5	—	12.67	13.34	10.43	8.60
May 1983	313.6	301.5	297.1	—	12.55	13.62	10.50	8.60
Jun 1983	315.3	302.4	298.1	214.55R	12.66	13.38	10.52	8.63
Jul 1983	316.5R	303.2	299.3	—	12.68	13.56	10.58	8.69
Aug 1983	317.5	304.9	300.3	—	12.63	13.46	10.61	8.64
Sep 1983	317.2	305.3	301.8	216.44R	12.71	13.47	10.69	8.75
Oct 1983	318.7	306.3	302.6	—	12.77	13.56R	10.78	8.73
Nov 1983	318.3P	305.6P	303.1P	—	—	—	10.85P	8.77P

P = Preliminary   R = Revised since last month

[1] US Bureau of Labor Statistics, Washington, D.C.: "Producer Prices and Price Indexes," (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

[2] US Bureau of Labor Statistics, Washington, D.C.: Consumer Price Index for All Urban Consumers, US City Average, All Items.

[3] US Department of Commerce, Washington, D.C.: Bureau of Economic Analysis, National Income and Wealth Division: "Survey of Current Business." The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

[4] US Bureau of Labor Statistics, Washington, D.C.: "Employment and Earnings." 2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for 1977-1978 are adjusted to the March 1979 benchmark. Data for January 1979 and beyond are adjusted to the March 1980 benchmark.

[5] Monthly data 1970-1978 for Producer Price Index-Industrial Commodities, Consumer Price Index, and Employment and Earnings SIC codes 10, 333, and 28, and quarterly data for GNP Implicit Price Deflator appear on pages 4.6-4.8 of Report 139.
Monthly data 1977-1978 for Employment and Earnings SIC Codes 10, 333, and 28 appear on page 33 of Report 147.
Monthly data 1970-1978 for Employment and Earnings SIC Code 36 appear on page 23 of Report 154.
Monthly data 1977-1980 for Producer Price Index-All Commodities, appear on page 21 of Nuexco Report 158.

[6] Monthly data 1979-1982 for all listed indices appear on page 41 of Report 184.

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EXECUTIVE SUMMARY
REPORT 186
(All data as of January 31, 1984)

Exchange Value **$20.50, down $1.50**	The **Exchange Value** is **$20.50** per pound U_3O_8, down $1.50 since last month. Five uranium sales transactions are reported, involving approximately 9.1 million pounds U_3O_8.
Supply-Demand Ratio **climbed to 8.3:1**	Active spot and near-term **uranium supply** amounts to **4.2 million** pounds U_3O_8 *equivalent*, down 1.7 million pounds from last month. Active spot and near-term **uranium demand** totals **510 thousand** pounds, down 2 million pounds. The spot and near-term **supply-demand ratio rose to 8.3:1.**
Transaction Value **unchanged at $23.05**	The **Transaction Value** is **$23.05** per pound U_3O_8, down $0.80 since last month. It includes 17 transactions involving a total of 2.9 million pounds U_3O_8 and equivalent UF_6 and covers a period of 7 months.
Loan Use Charge Rate **unchanged at 6%**	The **Loan Use Charge Rate** remains 6 percent per annum.
Conversion Value **remained at $0.60**	The **Conversion Value** is **$0.60** per pound U as UF_6, unchanged since last month. No conversion transactions are reported this month. Active secondary market supply of conversion services for delivery within three years totals 3.2 million pounds U as UF_6; active demand amounts to 330 thousand pounds. The conversion supply-demand ratio is 9.7 to 1.
SWU Values **$105 for DOE-origin (FY84)** **$85 for non-DOE origin** **(delivery within 15 months)**	The **SWU Values** are **$105** per SWU of DOE origin and **$85** per SWU of non-DOE origin, unchanged since last month. Three SWU transactions, involving a total of approximately 210 thousand SWUs, are reported this month. Active secondary market SWU supply amounts to approximately 1.2 million SWUs, while active demand totals 220 thousand SWUs. The limited near-term SWU demand is for FY84 DOE origin SWUs.
Enrichment	The final version of the Utility Services enrichment contract appears to offer some attractive concessions to enrichment customers. Some of the terms are analyzed in this Report.
Germany	Nuclear utilities encountered an irritating setback when construction halted at Isar Unit 1.
Netherlands	A nationwide survey early this year discovered there is little active support among the public for nuclear power, but the response to the survey was very small.
ANNUAL REVIEW: 1983	
Uranium Pricing	The uranium market recovered moderately but steadily into the third quarter of 1983, but by year-end prices had begun to decline.
Canada	The addition of Key Lake and the Stanleigh mine set Canada on a course to become the largest producing nation in the world.
Japan	Reductions to nuclear generating capacity forecasts led to some reevaluation of nuclear fuel cycle needs. Existing nuclear power plants set performance records.
South Africa	1983 U_3O_8 production rose despite low prices for gold and uranium.
United States	Four new units became operational and five approached that stage in 1983. However, high costs and regulatory problems hindered several nuclear power programs.
US Uranium Activities	Exploration and development continued to decline, as did US U_3O_8 production.
World U_3O_8 Production	Production worldwide declined from the 1982 level as the USA, Canada and Australia all decreased output.

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NUEXCO REPORT 186 FIGURES OF THE MONTH (January 31, 1984)	This Month (Report 186)	Last Month (Report 185)	12 Months Ago (Report 174)
Exchange Value[1]	20.50	22.00	21.50
Transaction Value[1]	23.05	23.85	19.35
Conversion Value[2]	0.60	0.60	1.20
Loan Use Charge Rate[3]	6%	6%	6%
Near-Term Uranium Supply[4]	4.2	5.9	9.4
Near-Term Uranium Demand[5]	0.5	2.5	4.7
Near-Term Supply-Demand Ratio	8.3	2.4	2.0
Recent Uranium Sales:			
Number of Transactions[6]	5	2	5
Quantity of material[7]	5.1-10.0	0.7-1.0	1.5-2.8
Nuexco SWU Values:[8]			
DOE origin, FY 84 delivery	105	105	
non-DOE origin, delivery within 15 months	85	85	
USDOE SWU Prices:			
USEC	135.00		
AFC	138.65	138.65	138.65
Requirements	149.85	149.85	149.85
Market Value of Enriched UF_6[9, 10]:			
2.5 w/o U_{235}	586.10	603.70	711.17
3.0 w/o U_{235}	752.87	774.39	917.87
3.5 w/o U_{235}	922.95	948.22	1,128.71
4.0 w/o U_{235}	1,095.28	1,124.37	1,342.62

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[1] US $ per pound U_3O_8 equivalent.

[2] US $ per pound U as UF_6.

[3] Per annum.

[4] Active inquiries to sell, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[5] Active inquiries to purchase, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[6] Uranium sales only; ~~does~~ not include loans, conversion, or SWU transactions.

[7] Millions of pounds U_3O_8, equivalent.

[8] US $ per SWU.

[9] Calculated using the Nuexco Exchange Value, Conversion Value, and 0.20 percent tails assay. Calculations before 2/28/83 used the USDOE price for AFC SWUs. From 2/28/83 through 9/30/83, calculations used the Nuexco SWU Value for the relevant fiscal year. As of 10/31/83, calculations use the SWU value for DOE origin and FY 84 delivery.

[10] US $ per KgU as UF_6.

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FEBRUARY 1984 NUMBER 186

Monthly Report on the Nuclear Fuel Market

NUEXCO

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MONTHLY REPORT ON THE NUCLEAR FUEL MARKET

February 1984 No. 186

R. WESLEY MILLER, *EDITOR* JAMES J. LIGHTNER, *ASSOCIATE EDITOR*

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To Our Readers

We are pleased to announce that Dr. **Karl Cohen** has joined Nuexco as a special consultant on enrichment technology. A pioneer in the field of nuclear energy, Dr. Cohen has a distinguished record. At the time of his retirement he was Chief Scientist of the Nuclear Energy Group, General Electric Company.

Dr. Cohen began work on uranium isotope separation in 1940, subsequently making major contributions to the theory of isotope separation and the methodology of gaseous diffusion and centrifugal separation. His 1945 book *Isotope Separation* is still the standard reference work in the field.

Dr. Cohen was an early advocate of the now standard light water reactor. At GE he formulated the development program for economic BWRs. He founded and chaired for eight years the company's Reactor Safeguards Council, and established and led the Advanced Reactor Department.

Dr. Cohen currently serves on the National Research Council panel reviewing the Waste Isolation Pilot Plant in New Mexico. He was elected to the National Academy of Engineering in 1967, and is a past President (1968–69) of the American Nuclear Society. He received the 1977 Krupp Foundation prize, and the 1979 Chemical Pioneer Award of the American Institute of Chemists, for his theory of gas centrifuges.

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NATURAL URANIUM AND CONVERSION

The **Exchange Value** as of January 31, 1984 is **$20.50** per pound U_3O_8, down $1.50 since last month. The *Current Market Data* section of this Report lists five uranium sales transactions, involving a total of approximately 9.1 million pounds U_3O_8 *equivalent*. Two of those transactions were long-term sales of U_3O_8, two were long-term sales of natural UF_6, and one involved a spot sale of natural UF_6.

Active supply of uranium (U_3O_8 and UF_6) for spot and near-term delivery totals **4.2 million** pounds U_3O_8 *equivalent*. **Active demand** for spot and near-term delivery totals **510 thousand** pounds U_3O_8 or equivalent UF_6. The spot and near-term **supply-demand ratio** rose dramatically to **8.3:1,** as several buyers previously classified as active withdrew from the market.

The **Transaction Value** as of January 31, 1984 is **$23.05** per pound U_3O_8, down $0.80 since last month. The current Transaction Value includes 17 transactions involving a total of 2.9 million pounds U_3O_8 or equivalent UF_6 and covers a period of 7 months.

The **Loan Use Charge Rate** as of January 31, 1984 is **6 percent** per annum, unchanged since last month. No uranium loans are reported.

* * *

The $1.50 drop in the Exchange Value as of January 31, 1984 came as a number of sellers competed vigorously for a limited number of bids to buy. In particular, offers made to one US utility that purchased a large quantity of natural UF_6 in the spot market severely undercut the previous month's Exchange Value. The contest for that business involved both producers and inventory holders, and signaled the willingness of many sellers to make offers well below those of previous months.

The near quadrupling of the supply-demand ratio for natural uranium also signaled a weakening price structure. Several buyers classified in the previous month's Report as "Active" withdrew from the market, reducing demand by approximately 2 million pounds. The previous level of demand was largely discretionary, and as prices have shown further weakness, some potential buyers with no real near-term needs have withdrawn temporarily in anticipation of a continuing price decline.

* * *

The **Conversion Value** as of January 31, 1984 is **$0.60** per pound U as UF_6, unchanged since last month. No conversion transactions are listed this month. Active secondary market supply of conversion services for delivery within three years totals 3.2 million pounds U as UF_6, while the corresponding demand figure is 330 thousand pounds. The secondary market conversion supply-demand ratio is 9.7 to 1.

Secondary market conversion activity was minimal during January, and, as with natural uranium, demand receded substantially despite the absence of near-term sales transactions. Buyer interest in this market segment appears to have been deterred by the large quantities of natural UF_6 available for sale, which continue to exert downward pressure on the Conversion Value. However, the present Conversion Value appears close to the indifference level of most sellers, who have resisted offering lower prices.

NATURAL URANIUM AND CONVERSION: 1983 REVIEW

Overview

Low, relatively stable prices and greater complexity characterized the market for natural uranium in 1983. Excesses of uranium in the hands of both producers and users prevented a strong price recovery, and at year-end led to renewed price cutting. Natural UF_6 comprised as much as half of the material actively for sale, in large part because of heightened activity in the secondary market for enrichment services. Users that succeeded in disposing of unneeded enrichment commitments were left with natural UF_6 inventories that required liquidation. The Conversion Value fell sharply in the fourth quarter as a result of the natural UF_6 glut.

Exchange Value

The Exchange Value reached $17.00, its lowest point in more than seven years, late in the summer of 1982. Thereafter and through the third quarter of 1983 it recovered modestly but steadily, reaching $24.00. By December 31 it had declined to $22.00, the approximate level of the first quarter of 1983. Table 1 lists the Exchange Value for each month of 1983.

During the third quarter, when the Exchange Value plateaued at the recent high of $24.00, buyers seemed to become more cautious, and market activity was sparse. In the fourth quarter some aggressive sellers attempted to stimulate greater buyer interest, setting in motion the subsequent price decline. Table 2 lists the spot and near-term

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supply and demand for natural uranium and the supply-demand ratio for each month of 1983. Demand remains highly discretionary in the first quarter of 1984.

Conversion Value

Sellers of conversion in the secondary market found little interest in their offers during most of 1983. The Conversion Value peaked in the first quarter of the year at $1.40 per pound U as UF_6 and then declined steadily to $0.60 per pound U, the level that persisted through the fourth quarter. Table 1 lists the Conversion Value for each month of 1983.

By the end of 1983, the Conversion Value applied only to buyers holding U_3O_8 that were explicitly interested in purchasing conversion *services*. This exclusion arose because certain aggressive sellers of natural UF_6 exhibited a willingness to sell at prices equal to competitive offers for U_3O_8, thus nullifying the value of the conversion component of their natural UF_6. In a few instances, buyers succeeded in negotiating prices for UF_6 that were *below* competititve prices for U_3O_8. As a result, sellers of conversion commitments met few buyers, a trend that has continued into 1984. Table 3 summarizes the secondary market supply and demand for conversion services for each month of 1983.

Loan Use Charge Rate

The Loan Use Charge Rate did not change during 1983, staying at 6 percent per annum, because active borrowers were practically nonexistent. A number of potential lenders continued to offer a relatively large and stable supply. Table 3 lists the supply and demand for natural uranium loans. Most potential lenders have been utilities holding large stockpiles of unneeded material, much of it natural UF_6. Potential borrowers seemed to lose interest completely in taking loans when the downturn in spot and near-term market prices commenced in the final quarter of 1983.

Table 1

1983 EXCHANGE VALUES, CONVERSION VALUES AND LOAN USE CHARGE RATES

Determined as of the Last Day of the Month	Report Number	Exchange Value[1] (per lb. U_3O_8)	Conversion Value[2] (per lb. U_3O_8)	Loan Use Charge Rate[3] (per annum)
January	174	$21.50	$1.20	6%
February	175	$21.75	$1.40	6%
March	176	$22.25	$1.40	6%
April	177	$23.25	$1.20	6%
May	178	$23.50	$1.20	6%
June	179	$23.50	$1.20	6%
July	180	$24.00	$1.10	6%
August	181	$24.00	$1.10	6%
September	182	$24.00	$1.00	6%
October	183	$23.50	$0.60	6%
November	184	$22.50	$0.60	6%
December	185	$22.00	$0.60	6%
Annual Average		$23.00	$1.05	6%

[1] Defined on page 10 of this Report. Historical data are reprinted in each Monthly Report.

[2] Defined on page 11 of this Report. Historical data are reprinted in each Monthly Report.

[3] Defined on page 11 of this Report. Historical Loan Use Charge Rates for 1968-1981 appeared in Report 162 on pages 32-34. Rates for 1982 in Report 173 on page 2.

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Table 2

1983 SPOT AND NEAR-TERM[1] SUPPLY AND DEMAND FOR NATURAL URANIUM
(Active Inquiries as Reported by Nuexco)

Determined as of the Last Day of the Month	Report Number	Uranium Supply[2] (Available for Sale)	Uranium Demand[2] (Inquiries to Purchase)	Supply-Demand Ratio	Exchange Value (per lb. U_3O_8)
January	174	9.4	4.7	2.0	$21.50
February	175	8.6	2.8	3.1	$21.75
March	176	7.5	2.9	2.6	$22.25
April	177	8.6	2.6	3.4	$23.25
May	178	5.9	3.1	1.9	$23.50
June	179	6.0	2.3	2.6	$23.50
July	180	7.1	2.6	2.8	$24.00
August	181	6.7	2.4	2.9	$24.00
September	182	7.2	4.4	1.7	$24.00
October	183	5.9	3.1	1.9	$23.50
November	184	5.7	3.1	1.8	$22.50
December	185	5.9	2.5	2.4	$22.00

[1] For delivery within one year.
[2] Millions of pounds U_3O_8 equivalent.

Table 3

1983 SUPPLY AND DEMAND FOR SECONDARY MARKET CONVERSION[1] AND NATURAL URANIUM LOANS[2]
(Active[3] Inquiries as Reported by Nuexco)

Determined as of the Last Day of the Month	Report Number	Conversion Supply	Conversion Demand	Loan Supply	Loan Demand	Exchange Value (per pound U_3O_8)
		(millions of pounds U as UF_6)		(millions of pounds U_3O_8 equivalent)		
January	174	3.3	0.2	3.2	1.7	$21.50
February	175	2.6	0.9	3.2	1.0	$21.75
March	176	3.0	0.7	5.1	1.0	$22.25
April	177	4.0	1.1	5.4	1.6	$23.25
May	178	7.0	1.8	4.9	1.1	$23.50
June	179	7.0	1.8	4.9	1.1	$23.50
July	180	7.0	1.8	5.0	1.1	$24.00
August	181	7.0	1.7	5.0	0.3	$24.00
September	182	5.4	1.8	4.0	0.3	$24.00
October	183	5.3	2.1	3.5	0.3	$23.50
November	184	3.5	1.3	3.5	0.3	$22.50
December	185	3.4	1.3	3.5	0.0	$22.00

[1] Data for Reports 174-177 refer to delivery within one year. Data for Reports 178-185 refer to delivery within three years.
[2] Data for all Reports refer to spot and near-term demand, i.e. material to be delivered to the *borrower* within one year.
[3] Involving competitive price, terms and other conditions.

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Analysis of Uranium Sales Transactions

Table 4 shows a breakdown of all 1983 transactions listed in the Report that involved natural uranium for delivery within one year of the date reported. The total quantity involved exceeded 11 million pounds U_3O_8 equivalent.

The number of utility inventory sellers declined sharply from recent years despite year-end indications that it would rise. Producers accounted for a much greater percentage of the sales than utilities, which seems to suggest that the market was edging toward conventional buyer and seller roles during 1983. The majority of uranium sold, however, came from sellers classified as "Other" in Table 4. They include government entities responsible for national uranium inventories, trading companies, and other organizations. Government entities in actuality performed much of the role played by utility inventory sellers during 1982. Trading companies in some cases were able to buy at low prices and sell at higher prices as the Exchange Value rose during the first half of 1983.

Utilities purchased approximately two-thirds of the uranium sold in 1983, while producers purchased only a tenth. These data call attention to the dramatic decline in producer buying from the levels of recent years. Other organizations bought approximately one-fourth of the uranium sold. It appears likely that this pattern of buying will continue in 1984; although some producers and trading companies may increase their purchasing activity. The distribution of *sellers* is liable to change more markedly, as utilities with recognized inventory surpluses attempt liquidation.

Transaction Value

Transactions included in the Transaction Value calculation are a subset of those listed under the category "Uranium Sales" in the *Current Market Data* section of each Report. Historically the Transaction Value, which is a weighted average of prices paid for natural uranium in spot and near-term transactions of immediately preceding months, has trailed the Exchange Value. This was true in 1983 as the Transaction Value recovered slowly from low spot prices of the second half of 1982, gained momentum in the first three quarters of 1983, and then levelled off in the final quarter in response to the drop in the Exchange Value. The Transaction Value and its associated parameters for each month of 1983 are listed in Table 5.

Late in 1983 the Transaction Value hovered above the Exchange Value for three straight months, demonstrating an unusually long delayed response to the concurrent decline in spot prices. Because few buyers actively sought to purchase for the spot and near term late in 1983, price cutting was reflected much more by sellers' offers than by completed sales transactions. No transactions at all were added to the Transaction Value calculation of December 31. Those transactions from the fourth quarter that were included generally involved quantities too small to push the old quantities (exchanged at higher prices) from the calculation, which requires a *minimum* of two million pounds of U_3O_8 or equivalent UF_6.

Thirty-seven 1983 transactions were used in the Transaction Value calculations. The weighted average price in those transactions was $22.55.

Table 4

BUYER AND SELLER GROUPS
IN 1983 URANIUM TRANSACTIONS[1] REPORTED BY NUEXCO
(percentage of total quantity bought and sold each month)

Report	Utility Buyer	Producer Buyer	Other[2] Buyer	Utility Seller	Producer Seller	Other[2] Seller
174	99	1	0	22	43	35
175	52	1	47	28	36	36
176	12	9	79	0	96	4
177	6	33	61	7	32	61
178	36	46	18	30	6	64
179	96	4	0	0	11	89
180	93	7	0	0	24	76
181	97	3	0	0	80	20
182	0	100	0	0	100	0
183	88	6	6	6	0	94
184	100	0	0	0	100	0
Year Total	66%	11%	23%	6%	44%	50%

[1] Natural uranium for delivery within one year of the date reported.
[2] Includes government entities, trading companies, and other organizations.

Table 5

1983 TRANSACTION VALUES[1]
(and Associated Parameters)

Determined as of the Last Day of the Month	Report Number	Transaction Value (per lb. U_3O_8)	Millions of Pounds	Number of Transactions	Number of Months
January	174	$19.35	5.4	12	3
February	175	$20.00	4.2	11	3
March	176	$21.35	2.8	12	3
April	177	$21.40	2.8	13	4
May	178	$22.35	2.1	16	4
June	179	$22.45	2.4	18	5
July	180	$23.50	2.6	19	5
August	181	$23.60	2.0	20	5
September	182	$23.65	2.0	21	6
October	183	$23.65	2.0	21	6
November	184	$23.85	2.3	16	5
December	185	$23.85	2.3	16	6

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[1] Defined on page 10 of this Report.

Table 6

1983 URANIUM LOANS AND SECONDARY MARKET CONVERSION TRANSACTIONS REPORTED BY NUEXCO

Loan Transactions

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current L.U.C.R.	Lender	Borrower
2106	unknown	101-300	108	US Utility	Canadian Producer
2281	1983	601-1,000	108	US Utility	US Producer
2607	1983	50-100	108	US Utility	US Producer
2624	1984	301-600	92	US Utility	US Producer

Secondary Market Conversion Services

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U equivalent)	Approximate Price as Percent of Current C.V.	Seller	Buyer
2097	1984	601-1,000	100 or more	European Utility	European Utility
2245	1983	101-300	less than 100	US Entity	US Utility
2449	1983	50-100	216	European Entity	European Utility
2473	1984	101-300	102	US Utility	US Utility
2505	1984	101-300	183	US Utility	European Utility
2617	1984	50-100	154	US Utility	European Utility

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Loans and Secondary Market Conversion Transactions

Table 6 lists all of the 1983 loans and secondary market conversion transactions that Nuexco reported. A total of four loans and six conversion transactions were reported, reflecting the minimal degree of activity in both markets. There are two particular items of interest regarding the listed transactions.

1. All four borrowers were producers, while the lenders were US utilities. The US utilities, having little or no near-term need for inventory, gained from the resultant interest and from the elimination of storage costs, while producers took advantage of low rates, presumably to meet near-term contract obligations.
2. European utilities comprised four of the six conversion buyers. In general, European utilities have shown more interest in the secondary market for conversion.

Analysis of Pricing Factors

Actual and anticipated inventory liquidations influenced prices in the nuclear fuel market heavily in the fourth quarter of 1983. Cancellations and delays of nuclear power units threatened to, and in many cases did, add uranium to the supply side of the market. Also, worldwide U_3O_8 production continued to exceed consumption by a large margin. Near-term uranium demand was small and largely discretionary throughout the year.

As prices declined during 1981 and 1982, higher cost producers, particularly in the USA, tended to cut back or close down operations and then purchase in the spot market the uranium needed to fulfill existing delivery commitments. However, even the existence of producer demand could not arrest the decline in the Exchange Value before it bottomed in 1982 at $17.00 per pound U_3O_8, the market having been overwhelmed by inventory selling. Most higher cost producers are now out of the market.

Approximately 80 percent of world production today comes from Canada, South Africa, Namibia, Australia, Niger, Gabon and France. Contracts and client relationships in these countries tend to be longer-term and of a different character than those typically found in the USA. These non-US producers are unlikely to suspend operations in favor of open market purchases. Therefore, new producer demand is unlikely to arise in the near future.

The current market situation points to a new structural rigidity. Little flexibility exists in either the production or consumption sectors. Spot prices could vary sharply in the near term as they seek a level that will lead to the movement of material. The situation could be volatile, particularly in the event of unforeseen occurrences affecting nuclear power.

While significant unfilled utility demand exists beginning in the middle to late 1980s, particularly in the USA, utilities have shown no urgency to buy. The existence of large, publicly visible inventories in weak hands has eased any concerns about security of supply both in the near-term and longer-term markets. In the past, US utilities would make new contracts well in advance of their unfilled requirements. However, US utility psychology has changed. Utilities are much more willing to wait until the last minute to purchase uranium. Even if they are wrong about future prices, they can buy at spot prices and avoid criticism. To create new demand, prices must decline to a level at which buyers view current purchases plus carrying costs as more attractive than long-term purchases from primary suppliers.

For the balance of 1984, a spot and near-term price rise is highly unlikely. Recent cancellations of nuclear power units in the USA have had a devastating psychological impact, and they have had an important *actual* impact on spot and near-term market supply. The Marble Hill (Public Service of Indiana) and Zimmer (Cincinnati Gas and Electric) cancellations suddenly made available for sale an additional 5 million pounds U_3O_8 equivalent. While the WPPSS (Washington Public Power Supply System) situation is developing more slowly, it represents another 5 million pounds U_3O_8 equivalent. This material is in various forms, including fabricated fuel, so much of it is less easily sold than is yellowcake. But the lack of operating reactors makes it impossible for its owners to hold the material in inventory for the time being and to consume it at a later date. The market is ripe for aggressive price cutting by the many current holders of inventory.

A final factor liable to have a powerful influence on uranium pricing is the new DOE enrichment contract, the USEC. The contract enables customers gradually to dispose of excess SWUs contracted in the past and to align enrichment services closely with actual reactor needs. Consequently, as utilities convert to the new contract, demand for feed material to fill old contract obligations will diminish. Any reductions in uranium demand will contribute to the general downward pressure on prices.

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SECONDARY MARKET ENRICHMENT SERVICES

The secondary market **SWU Values** as of January 31, 1984 are **$105 for DOE origin** and FY84 delivery, and **$85 for non-DOE origin** and delivery within 15 months. Both SWU Values are unchanged since last month. The *Current Market Data* section of this Report lists three SWU transactions involving a total of approximately 210 thousand SWUs. Active secondary market supply of enrichment services totals approximately 1.2 million SWUs, and active demand amounts to approximately 220 thousand SWUs. The near-term supply-demand ratio is 5.4 to 1; all of the existing demand is for SWUs of DOE origin.

* * *

There was little apparent change in the secondary SWU market during January, as few transactions were completed. The major development, which did not have time to affect buying and selling activity, was the announcement of the terms of the final USEC. It contains a provision, among others, allowing former holders of Requirements contracts to substitute at no charge DOE origin SWUs for up to 30 percent of requirements for FY84-86 deliveries. Over the next few months, both buyers and sellers will be evaluating enrichment strategies for the future in light of the new DOE contract.

TERMS AND CONDITIONS OF THE REVISED USEC

Introduction

DOE issued the final, revised version of the USEC and the associated terms and conditions of conversion on January 18. The final version incorporates a number of important changes from the draft USEC, which was analyzed in last month's Report. Those changes ostensibly were made in response to customers' comments on the draft. However, the time interval for customer comments was noticeably shorter than is customary, so there has been considerable speculation that DOE had already settled on the final version when the draft was issued on December 30. This article describes the most important changes to the contract draft.

Conversion Terms and Conditions

1. The date for a commitment to conversion has been delayed three months, until *October 1, 1984.*
2. All nuclear facilities under contract with DOE must be converted together (as in the draft), but future nuclear facilities would be included *at the customer's request.*
3. Termination notices given after December 31, 1983, but *in furtherance of sales transactions completed before December 31, 1983* may be incorporated.
4. AFC contract holders that convert must still accept 100 percent of their FY84 Appendix A commitments, but may now reduce FY85 commitments by 10 percent and FY86 commitments by 25 percent. Appendix A commitments beginning FY87 are eliminated.
5. Requirements contract holders may convert immediately, and select an immediate 70 percent minimum purchase obligation. The remaining requirements through FY86 must come from DOE origin material. This provision allowing for free substitution of a portion of requirements will help to promote an *active secondary market in DOE origin SWUs,* at least through FY86.

Contract Terms and Conditions

1. Customers may specify a commitment to take from 70 to 100 percent of requirements on a *five-year rolling period,* reduced from ten years.
2. The contract ceiling price is fixed at $135 per SWU through September 30, 1985, but now includes adjustments intended to reflect changes in DOE's costs, including changes in electricity rates, as well as the GNP Implicit Price Deflator.
3. DOE may now charge a price that exceeds the ceiling only with 10 years' notice.
4. Termination charges are reduced to zero with 10 or more years' notice.

In many instances, contract terms and terms of conversion are vague. Ultimately, their definition will be accomplished by the mechanism of policy rulings as discussion continues between DOE and its customers. The contract allows DOE and the customer to "amend this contract . . . to provide terms desirable to the parties, if providing such terms would be in the interest of the Government under the circumstances." Already a number of instances have been reported wherein DOE has indicated to some customers a desire to use that clause to its maximum advantage in encouraging conversion to the USEC.

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USEC AND REQUIREMENTS CONTRACTS: COMPARISON OF PRICE CEILING ESCALATION TERMS

An analysis of the price ceiling terms of the Utility Services enrichment contract (USEC) indicates that the SWU price advantage relative to existing DOE contract prices may be more apparent than real. The USEC ceiling could rise faster than that of the Requirements contract, and, as Adjustable, Fixed-commitment (AFC) contracts customarily are priced below the level of the Requirements contract, the USEC ceiling in the future may also exceed the AFC price.

USEC Pricing

The USEC sets the SWU price ceiling at $135, 100 percent escalated from June 30, 1984. The first annual ceiling adjustment is scheduled to take place in October 1985 according to the following criteria.

1. $67.50 of the price ceiling (50 percent of the base) is adjusted according to the change in the US GNP Implicit Price Deflator (GNPIPD). The GNPIPD is a measure of the US inflation rate.
2. $47.50 of the ceiling (35.2 percent of the base) is adjusted according to the change in the *energy rate* charged to DOE for the electricity supplied to its Gaseous Diffusion Plants. The energy rate addresses the variable cost of power actually used by DOE.
3. $20.00 of the ceiling (14.8 percent of the base) is adjusted according to the change in the electrical power *demand rate* charged to DOE. The demand rate is based on a fixed charge covering the total amount of power DOE is contracted to take, including power not taken.

The escalation formula differs considerably from that of the draft USEC, which based adjustments exclusively on changes in the GNPIPD. The final escalation terms correlate closely with DOE's existing cost structure, and provide DOE with some protection against future increases in the cost of power.

Pricing Terms of Existing Contracts

The current price ceiling for DOE Requirements contracts is $151.93. This ceiling (contained in both 3.5-year and 5-year Requirements contracts), has a base of $30, 33 percent of which is not escalated at all, and 67 percent of which is escalated according to the following formula.

1. $15 (50 percent of the base) is adjusted according to changes in the average *total power cost* that DOE pays to its electricity suppliers.
2. $5 (16.7 percent of the base) is adjusted according to changes in the costs for labor in Chemical and Allied Products Industries (US Bureau of Labor Statistics, SIC 28).

The AFC contract, first issued in 1978, does not contain a conventional price ceiling. However, it does contain a provision permitting customers to terminate the contract at no cost if the SWU price exceeds 130 percent of that price which represents full cost recovery for the US government. DOE considers AFC contracts less risky because they, unlike Requirements contracts, do not require DOE to deliver SWUs according to a schedule that can change with as little as 180 days notice. Consequently, DOE historically has established the AFC price well below the Requirements SWU price. Nevertheless, DOE determines exactly what price represents full cost recovery. Therefore, the prices of SWUs under AFC contracts may be subject to arbitrary manipulation by DOE.

Trends in Escalation Terms

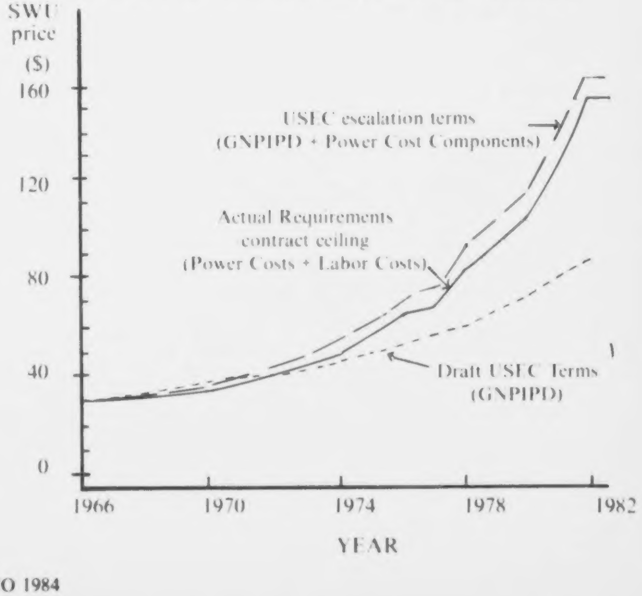
Figure 1 compares three curves:

1. the actual Requirements contract price ceiling from 1966 1983;
2. the hypothetical ceiling had the escalation terms of the final USEC applied;
3. the hypothetical ceiling had the escalation terms of the draft USEC applied.

Since 1965, the base year of the Requirements contract, the average total power cost that DOE pays has risen an astounding 720 percent. Labor costs have risen 270 percent. The sharp rise in total power costs came during the 1970s, when energy price inflation was rampant.

Figure 1

COMPARISON OF REQUIREMENTS CONTRACT PRICE CEILING WITH HYPOTHETICAL CEILINGS USING USEC ESCALATION TERMS



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Fifty percent of the USEC base is adjusted to power costs in their component forms, so had the escalation terms of the USEC applied to the Requirements contract, the ceiling would have risen equally dramatically. The other 50 percent of the USEC base is adjusted to the GNPIPD; that index has risen steadily over the past twenty years (180 percent from 1965).

Future Ceiling Levels

Although it is difficult to project future trends in the relevant escalation indices, certain observations support the conclusion that the USEC price ceiling may rise faster than the existing Requirements contract ceiling.

1. Escalation provisions apply to only 67 percent of the Requirements base. 100 percent of the USEC base is escalated.

2. Generally the GNPIPD rises steadily, while power costs are influenced by independent variables, namely energy charges and demand charges.

3. In an effort to reduce costs to the US government, DOE has been attempting to reduce demand charges, and particularly charges for power not taken levied by the Tennessee Valley Authority (TVA). If DOE's demand charges are diminished, average total power costs, according to which 50 percent of the Requirements base is adjusted, will fall substantially. Only 14.8 percent of the USEC base is adjusted to demand charges, so reducing them would have a lesser impact on USEC escalation.

Nuexco estimates that the 1984 power cost used in the Requirements contract ceiling escalation will be approximately 35.7 mills per kilowatt hour (m kwh). That estimate *includes* the component of the charge for power not taken. Eliminating that component would reduce DOE's expected total power cost to 28 m kwh. Assuming an 8 percent annual escalation for the labor cost index, the 1984 Requirements contract price ceiling will be approximately $165 if the power not taken charge is included in the demand rate, and $135 if it is eliminated.

USEC TERMINATION CHARGES

The charge for termination under the draft version of the USEC was defined as the price of one SWU (S) minus the price component representing the energy portion of the electric power charge (E) times the number of cancelled SWUs (C) times a multiplier (M) that is based on the notice period given by the customer.

$$\text{Termination Charge} = (S - E)(C)(M).$$

The final version of the USEC contained an added proviso, that M = 0 if notice is given ten years or more in advance of scheduled deliveries.

The General Accounting Office (GAO) analysis of DOE's power costs for the next 10 years estimates that the energy portion of the electric power charge to DOE will average 65 percent of total power costs. (The remaining 35 percent will be comprised of demand charges.) DOE's FY84 breakdown of the AFC contract price shows total power costs of $67 per SWU, representing 48 percent of the contract price ($138.65). Using the GAO figure of 65 percent, the energy component of the AFC SWU price is equal to 0.65 × 48 = **31 percent.** If the energy component were to remain constant at 31 percent, the absolute value of the USEC termination charge would be as shown in Table 7.

Table 7

COMPARISON OF TERMINATION CHARGES

Notice Period (years)		Percentage of SWU Price		
More Than	Not More Than	USEC[1]	Requirements 5-year	Requirements 3.5-year
0	1	69	40	25
1	2	62	40	20
2	3	55	40	15
3	4	48	40	10
4	5	41	40	0
5	6	34	0	0
6	7	28	0	0
7	8	21	0	0
8	9	14	0	0
9	10	7	0	0
10+		0	0	0

[1] Assumes energy component of power costs equal to 31 percent of SWU price.

The termination charge as a percentage of the USEC SWU price would increase if DOE were to begin operation of the Gaseous Centrifuge Enrichment Plant (GCEP) or Advanced Laser Isotope Separation Process (AVLIS). For those technologies the energy component would be a smaller fraction of the total SWU cost, so the credit associated with the energy component would be reduced.

The only significant change in the termination terms from the draft to the final version of the USEC is the ability to terminate at no cost with 10 or more years notice. Although the USEC allows partial termination, former Requirements customers will be able to obtain required enrichment services from non-DOE suppliers only by paying termination charges that are much higher than those specified in their present contracts (Table 7). Except for the contract provision allowing free substitution of a limited number of DOE SWUs from another DOE customer, the USEC makes termination for secondary market participation an unattractive option.

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CURRENT MARKET DATA

EXCHANGE VALUE $20.50/lb. U_3O_8
Determined as of January 31, 1984

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE[1]
Determined as of January 31, 1984

$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
23.05	2.9	17	7

Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in:

A. Transactions closed within the previous three-month period for which delivery was scheduled within one year of the transaction date;
B. At least ten transactions;
C. Transactions involving a sum total of at least two million pounds U_3O_8 equivalent.

The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars as of the transaction date.

Comments

Nuexco does not consider the following in determining the Transaction Value:

A. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.
B. The price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of Exchange Value or any other independent variable.
C. Transactions in which the delivery price is defined in such a way that it cannot currently be determined.

[1] Transaction Values for 1976 through 1981 and their associated parameters (millions of pounds, number of transactions and number of months) are tabulated on pages 31 and 32 of Report 161. The corresponding data for 1982 are tabulated on page 5 of Report 173, and for 1983 on page 5 of Report 186.

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CURRENT MARKET DATA

LOAN USE CHARGE RATE[1] 6%
Determined as of January 31, 1984

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrows and lenders have expressed as a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

[1] Monthly data for 1968 through 1981 appear on pages 32 34 of Report 162. Monthly data for 1982 appear on page 2 of Report 173.

CONVERSION VALUE $0.60/lb. U as UF_6
Determined as of January 31, 1984

Definition

The Conversion Value is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.

Derivation

Nuexco bases the Conversion Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Conversion Value:

A. The price of conversion services delivered or to be delivered under old contracts.
B. The price of conversion services delivered in connection with contract renegotiations or other than arm's length transactions.
C. Transportation charges other than those customarily provided by primary suppliers of conversion services.

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CURRENT MARKET DATA

SWU VALUES

$105/SWU FOR DOE ORIGIN AND FY84 DELIVERY
$85/SWU FOR NON-DOE ORIGIN AND DELIVERY WITHIN 15 MONTHS
Determined as of January 31, 1984

Definition

The SWU (Separative Work Unit) Values represent Nuexco's judgment of the price, expressed in US dollars per SWU, at which transactions for the sale of significant quantities of SWUs of stated origin for delivery in the specified time period could be concluded as of the date indicated.

Derivation

Nuexco bases the SWU Values upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.
E. SWU prices at varying tails assays and varying product assays are converted to the equivalent SWU price at the DOE Reference Transaction Tails Assay (presently 0.20 weight percent U_{235}) and a product assay of 3.0 weight percent U_{235} assuming feed costs calculated using the Nuexco Exchange Value and Nuexco Conversion Value determined as of the last day of the same month.

Comments

Nuexco does not consider the following in determining the SWU Values:

A. The price of SWUs delivered under long-term contracts from primary suppliers, such as DOE, Urenco, or Eurodif.
B. The price of SWUs delivered under other than arm's length transactions.

EXCHANGE RATES[1]
(Currency per US Dollars)

Country (currency)	This Month (Jan 31, 1984)	Last Month (Dec 29, 1983)	12 Months Ago (Jan 28, 1983)	Percent Change Over 12 Months
Australia (dollar)	1.09	1.11	1.03	5.8
Belgium (comm. franc)	57.44	55.70	47.72	20.4
Canada (dollar)	1.25	1.24	1.24	0.8
Finland (markka)	5.94	5.83	5.40	10.0
France (franc)	8.60	8.34	6.87	25.2
FRG (mark)	2.81	2.73	2.43	15.6
Italy (lira)	1713.00	1661.00	1403.00	22.1
Japan (yen)	234.57	232.05	236.20	0.7
Netherlands (guilder)	3.16	3.07	2.67	18.4
South Africa (rand)	1.27	1.22	1.07	18.7
Spain (peseta)	158.55	157.55	128.90	23.0
Sweden (krona)	8.18	8.01	7.43	10.1
Switzerland (franc)	2.24	2.18	1.99	12.6
UK (pound)	0.71	0.69	0.65	9.2
US (dollar)	1.00	1.00	1.00	0.0

[1] Currency exchange rates from the *Wall Street Journal* of the date indicated.

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EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates	per lb. U_3O_8 12 Months Ago
Australia (dollar)	22.33	49.24	58.06	22.07
Belgium (comm. franc)	1,177	2,596	3,061	1,029
Canada (dollar)	25.60	56.43	66.54	26.56
Finland (markka)	121.81	268.54	316.67	116.03
France (franc)	176.42	388.94	458.65	148.07
FRG (mark)	57.65	127.09	149.87	52.26
Italy (lira)	35,121	77,428	91,306	30,197
Japan (yen)	4,809	10,602	12,502	5,078
Netherlands (guilder)	64.83	142.93	168.55	57.41
South Africa (rand)	25.98	57.28	67.55	22.92
Spain (peseta)	3,250	7,166	8,450	2,771
Sweden (krona)	167.76	369.84	436.13	159.73
Switzerland (franc)	45.97	101.36	119.52	42.76
UK (pound)	14.56	32.11	37.87	13.98
US (dollar)	20.50	45.19	53.30	21.50

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates	per lb. U_3O_8 12 Months Ago
Australia (dollar)	25.11	55.36	65.28	19.86
Belgium (comm. franc)	1,324	2,919	3,442	926.10
Canada (dollar)	28.78	63.45	74.82	23.90
Finland (markka)	136.96	301.94	356.06	104.43
France (franc)	198.36	437.32	515.70	133.26
FRG (mark)	64.82	142.90	168.52	47.03
Italy (lira)	39,489	87,059	102,664	27,177
Japan (yen)	5,407	11,920	14,057	4,570
Netherlands (guilder)	72.90	160.71	189.52	51.67
South Africa (rand)	29.21	64.41	75.95	20.63
Spain (peseta)	3,655	8,057	9,501	2,494
Sweden (krona)	188.63	415.85	490.38	143.76
Switzerland (franc)	51.69	113.96	134.39	38.48
UK (pound)	16.38	36.10	42.58	12.58
US (dollar)	23.05	50.82	59.92	19.35

[1] Calculated using currency exchange rates published in the *Wall Street Journal* on January 31, 1984.

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NUEXCO

CURRENT MARKET DATA

CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U as UF6	per kg U as UF6	per lb. U 12 Months Ago
Australia (dollar)	0.65	1.44	1.23
Belgium (comm. franc)	34.46	75.98	57.42
Canada (dollar)	0.75	1.65	1.48
Finland (markka)	3.57	7.86	6.48
France (franc)	5.16	11.38	8.26
FRG (mark)	1.69	3.72	2.92
Italy (lira)	1,028	2,266	1,685
Japan (yen)	140.75	310.29	283.42
Netherlands (guilder)	1.90	4.18	3.20
South Africa (rand)	0.76	1.68	1.28
Spain (peseta)	95.13	209.73	154.68
Sweden (krona)	4.91	10.82	8.92
Switzerland (franc)	1.35	2.97	2.39
UK (pound)	0.43	0.94	0.78
US (dollar)	0.60	1.32	1.20

SWU VALUES EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU FY84	Non-DOE SWU delivery w/in 15 mo.
Australia (dollar)	114.39	92.60
Belgium (comm. franc)	6,031	4,882
Canada (dollar)	131.10	106.13
Finland (markka)	623.89	505.05
France (franc)	903.61	731.50
FRG (mark)	295.28	239.03
Italy (lira)	79,887	145,623
Japan (yen)	24,631	19,939
Netherlands (guilder)	332.07	268.82
South Africa (rand)	133.08	107.73
Spain (peseta)	16,648	13,477
Sweden (krona)	859.25	695.58
Switzerland (franc)	235.48	190.63
UK (pound)	74.60	60.39
US (dollar)	105.00	85.00

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[1] Calculated using currency exchange rates published in the *Wall Street Journal* on January 31, 1984.

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RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
2661	1984-93	1,501-3,000	indeterminate	Canadian Producer	European Utility	UF_6.
2652	1984	601-1,000	97	Canadian Producer	US Utility	UF_6. Assumes conversion cost of $0.60 per lb. U.
2645	1985-92	1,001-1,500	indeterminate	US Producer	US Utility	Price related to market.
2644	1985-89	601-1,000	indeterminate	US Producer	US Utility	Price related to market.
2598	1988-97	3,000-5,000	indeterminate	Canadian Producer	European Utility	UF_6. Price related to market.

Secondary Market Enrichment Services

Nuexco Transaction Number	Delivery Period[2]	Approximate Quantity (thousands of SWUs)	Approximate Price[3] as Percent of Current SWU Value[4]	Tails Assay (Percent U_{235})	Seller Group	Buyer Group	SWU Origin	Remarks
2660	1984	0-50	unknown	0.2	US Utility	European Utility	DOE	
2634	1989	50-100	indeterminate	to be determined	European Entity	European Utility	Eurodif	
2608	1985	101-300	100-104	0.3	Mexican Utility	US Utility.	DOE	

[1] Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.

[2] Refers to calendar year, not fiscal year.

[3] Price is not normalized to 0.20% tails assay.

[4] Refers to SWU Value for same origin as SWUs included in transaction.

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CURRENT MARKET DATA

URANIUM SUPPLY
(As of 1/31/84)

	Delivery Period[1] (Thousands of Pounds U_3O_8)		
Nuexco Project Number	**Spot or Near-term[2]**	**Intermediate or Long-term**	**Remarks**
Available for Sale:			
ACTIVE			
1575	—	500 per year	1985 on
1818	—	500 per year	1984-90
2038	1,000	—	UF_6
2134		250 per year	1984-87
2201	300	—	
2203	—	1,000 per year	1984-93
2220	150	—	UF_6
2236	—	200 per year	1985-89
2263	—	500 per year	1985-90
2274	—	600 per year	1985-91
2275 A	110		
2297	—	200 per year	1985-89
2307	340	—	UF_6
2315	170	950	UF_6
2335	200	—	
2336	—	250 per year	1985 on
2350	30	—	
2365	20	—	
2366	600	—	1984-85
2376	50	—	UF_6
2389	300	—	
2390	500	—	
2429	450	—	
TOTAL:	4,220		
INACTIVE			
0564	—	1,000 per year	1986-90
2017	1,100	1,200	
2191	125		UF_6
2193	—	800 per year	1986-90
2271	—	500 per year	1984-85
TOTAL:	1,225		

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[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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URANIUM DEMAND
(As of 1/31/84)

	Delivery Period[1] (Thousands of Pounds U_3O_8)		
Nuexco Project Number	**Spot or Near-term[2]**	**Intermediate or Long-term**	**Remarks**
Inquiries to Purchase:			
ACTIVE			
2217	—	8,700	1988 on
2302	—	330 per year	1988 on
2313	220	—	
2329	—	500	1985
2352	240	—	
2413	—	250 per year	1987-88
2419	50	—	UF_6
TOTAL:	510		
INACTIVE			
1999	—	50 per year	1985-90
2118 A	250	—	
2244	—	350 per year	1985 on
2310 A	800	—	enriched UF_6
2372	—	250 per year	1985-88
2411	300	—	
2414	—	100 per year	1987-91 U_3O_8 or UF_6
TOTAL:	1,350		

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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LOAN SUPPLY AND DEMAND
(As of 1/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Within 1 Year	Beyond 1 Year	Remarks
Available for Loan:			
ACTIVE			
1938	1,500	—	UF_6
2128	1,000	—	
2483	545	—	
TOTAL:	3,045		
INACTIVE			
2036	500	—	UF_6
2139	2,000	—	
TOTAL:	2,500		
Inquiries to Borrow:			
INACTIVE			
2118	250	—	U_3O_8 or UF_6
TOTAL:	250		

[1] Measured from the date of this Report.

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CONVERSION SUPPLY AND DEMAND
(As of 1/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF_6) Within 3 Years	Beyond 3 Years	Remarks
Available for Sale:			
ACTIVE			
2051	1,500	—	
2141	1,500	—	
2220 A	210	—	
TOTAL:	3,210		
INACTIVE			
1936	1,500	—	
2230	300	—	
2401	600	—	
TOTAL:	2,400		
Inquiries to Purchase:			
ACTIVE			
2386	330		
TOTAL:	330		
INACTIVE			
2287	—	250 per year	1987 on
2295	200		
2372 A		250 per year	1985 on
2420	310		
TOTAL:	510		

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[1] Measured from the date of this Report.

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CURRENT MARKET DATA

SWU SUPPLY
(As of 1/31/84)

	Delivery Period[1] (Thousands of SWUs)		
Nuexco Project Number	**Spot or Near-term[2]**	**Intermediate or Long-term**	**Remarks**
Available for Sale:			
ACTIVE			
1895	—	500	
2040	55	—	
2052	270		
2100	—	100 per year	1984-89
2164	80	—	
2189	85	80	1985
2192	—	325	
2210	—	70	1985
2285	500	3,000	
2345	—	500	1985
2351	—	150 per year	1985-91
2359	180	—	
2378	—	120 per year	1985-88
2408	—	120	1985
2428	—	200	1985
TOTAL:	1,170		
INACTIVE			
2337	250	250	
2375	200	—	
TOTAL:	450		

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

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SWU DEMAND
(As of 1/31/84)

	Delivery Period[1] (Thousands of SWU's)		
Nuexco Project Number	**Spot or Near-term[2]**	**Intermediate or Long-term**	**Remarks**
Inquiries to Purchase:			
ACTIVE			
2142	—	35	1985
2233	85	—	
2346	—	100 per year	1985-90
2355	—	180 per year	1986,88,90,92
2374 B	—	90	1985
2382	—	110	1985-86
2391	60	40	1985
2400	—	85	1985
2412	—	80	1985
2448	70	—	
TOTAL:	215		
INACTIVE			
2237	—	250 per year	1985 on
2310	200	—	
2450	—	100	1987
TOTAL:	200		

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

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FEDERAL REPUBLIC OF GERMANY

The FRG's nuclear power program suffered an aggravating setback in January when a court order forced a stop to construction on Isar Unit 2, owned by Bayernwerk (40 percent), Isar-Amperwerke (25 percent), Stadtwerke Muenchen (25 percent), and Energy Versogung Schwaben (EVS) (10 percent). A local landowner filed suit against the owners on the basis that the plant was unsafe, and in considering the case the court discovered what it considered to be a design problem.

The original design of the so-called "convoy" units (Table 8), of which Isar Unit 2 is one, provided for braces to be constructed around certain steam pipes to prevent them from swinging in the event of pipe breakage. Subsequently it was determined that braces are unnecessary because the probability of pipe breakage is small and the potential damage from swinging pipes limited. The requirement for these braces was therefore stricken from the convoy plant design.

The German court ruled that construction must be halted until the change to the plant design has been subjected to the required public hearing. Thus, on January 16, work on Isar Unit 2 ceased and some 1,000 workers were laid off. The utilities are upset about the loss of time and money that will ensue, and a segment of the local population is angered by the loss of work. On the other hand, anti-nuclear advocates are rallying to this opportunity to hamper the nuclear industry.

The four utilities involved immediately appealed the decision on the basis that the design change was very minor and did not necessitate a full public hearing. The results of this appeal are still pending. In any event, it is estimated that this incident will cause a minimum delay of six months, and should a full public hearing be required, the delay could extend to three or four years.

One obvious solution would be to install the braces as previously proposed. However, such an action if taken would constitute an open invitation to anyone to challenge minor changes in nuclear units. In addition, the installation of the braces might force the same action on the other owners of convoy units.

Meanwhile, owners of other convoy units are considering their own situations, and are trying to decide if they should install the braces, hold open public hearings on the design changes, or simply continue construction. And of course they are anxiously awaiting the results of the appeal of the ruling on Isar Unit 2.

NETHERLANDS

A nationwide attempt to reach a collective decision regarding the future of nuclear power in the Netherlands has come to a disappointing and somewhat inconclusive end. All over Holland the government distributed questionnaires so that private citizens could express their opinions on nuclear power. When the counting was finished, there were only some 25,600 respondents from this country of 14.3 million. Of those, 14 percent favored nuclear energy, 31 percent questioned the value of nuclear power, and 50 percent openly opposed nuclear power.

There seemed to be a consensus among respondents that the two existing units in the Netherlands, Dood-

Table 8

CONVOY UNITS IN THE FEDERAL REPUBLIC OF GERMANY

Unit	Primary Utility	Type	Output (MWe net)	Percent Complete	COD[1]
Under Construction					
Isar 2	Bayernwerk	PWR	1285	25	1988
Emsland	VEW	PWR	1222	10	1989
GKN-2	GKN	PWR	1230	15	1990
Planned					
Wyhl	Badenwerk EVS	PWR	1284	0	indefinite
Biblis C	RWE	PWR	1237	0	indefinite
Total MWe			6,258		

[1] Commercial Operating Date. Based on published sources and utility forecasts.

waard and Borsele, should continue operating because the cost to close them (estimated at anywhere between $300 million and $1.3 billion) would be prohibitively high, and some value was perceived in continuing the research aspect of the reactors. However, the responding group also felt that no new reactors should be built until an adequate waste disposal plan has been developed.

While not binding on the government or utilities, the survey was intended to clarify the national position on this issue. In fact, the limited response to the survey may be most indicative of apathy. Future nuclear plant construction is likely to be based on capital costs and load growth rates rather than on the results of opinion polls.

CORRECTIONS TO PREVIOUS REPORTS

Free World Convertors

On page 28 of last month's Report (Number 185), in the article entitled *Nuclear Power in the United Kingdom*, the first sentence under the heading "Fuel Cycle Services" incorrectly reads: "BNFL, which operates the largest conversion facility in the Free World, provides for most of the upgrading, manufacture and reprocessing of fuel needed by the domestic nuclear program."

The sentence should state that BNFL operates the *fourth* largest conversion facility in the Free World. Based on name plate rating, Eldorado in Canada has the largest conversion operation at 14,500 MTU annually (9,000 MTU of which is new capacity). Eldorado is followed by Allied in the USA (12,700 MTU), Comurhex in France (12,000 MTU), BNFL in the United Kingdom (9,500 MTU), and Sequoyah Fuels Corp. (formerly Kerr-McGee) in the USA (9,100 MTU).

Japanese Electricity Generating Plants

On page 30 of the last Report (Number 185), in the article entitled *Japan's Nuclear Power Infrastructure*, Table 6 lists the total number of operating electricity generating plants in Japan as 3,429. The total should read 2,429.

Canadian Government Statistics

Since March of 1983 (Report 175) the table of Canadian Government Statistics has listed an average hourly earnings wage earner series under the incorrect title "Metal Mining, Including Milling (SIC 050-099)." The *correct* title, as shown in this Report, is "Mines, Quarries and Oil Wells (SIC 051-099)." The numbers published were correct for that earnings series.

The *Government Statistics* section of this Report lists average hourly earnings data for three separate wage earner series in Mining:

1. Mines, Quarries and Oil Wells (SIC 051-099);
2. Metal Mines (SIC 051-059);
3. Uranium Mines (SIC 057).

These three series will be continued in future Reports.

CANADA

With the addition in 1983 of the new Key Lake mine and the recommissioned Stanleigh mine, Canada's U_3O_8 production rate has surpassed that of the USA as the foremost in the world. Nuexco's recent survey of Canadian production operations indicates that Canada's 1983 U_3O_8 output totaled approximately 19 million pounds, over 60 percent of which came from the province of Ontario, with the balance from Saskatchewan. Saskatchewan is expected to produce at a higher annual rate early in 1984.

Key Lake Startup

The opening of the Key Lake operation highlighted uranium developments during 1983. Plant construction took just over two years and cost approximately 90 percent of the projected $500 million. Milling of ore began on October 3, 1983, and the first drum of yellowcake was packaged on October 20. By year-end the mine had produced almost 1.6 million pounds. Key Lake is now the largest operating uranium mine in the world. Reserves total some 200 million pounds U_3O_8 at an average grade of 2.35 percent. The operation's design capacity of 1 million pounds U_3O_8 per month should be reached by the third quarter of 1984.

Key Lake is owned jointly by Saskatchewan Mining Development Corporation (SMDC) (50 percent), Uranerz Exploration and Mining, Ltd. (33.33 percent) and Eldor Resources, Ltd. (16.67 percent). SMDC already has contracts committing 80 percent of its share of production through 1990. SMDC, which also owns a 20 percent share of Cluff Lake in Saskatchewan (Amok, Ltd. owns the other 80 percent) and a 50.75 percent of the promising Waterbury deposit, has joined the ranks of the largest uranium producers with 6.5 million pounds annual share of production.

Cigar Lake Discovery

Following detailed work in the Cigar Lake area, SERU Nucleaire, the operator of the Waterbury Joint Venture, defined a rich uranium-bearing orebody in 1983. By year-end sixty-five holes had been drilled over a 600 meter length, with some holes having average grades up to 25 percent. Reserve estimates exceed 125 million pounds U_3O_8 at an average grade of 5-10 percent. Waterbury is a deeper deposit than Key Lake; in the holes drilled, mineralization occurred at depths of 410-440 meters. Drilling will continue in 1984 in an effort to extend the proven reserves. In addition to SMDC's 50.75 percent share, SERU Nucleaire owns 33.625 percent of the venture, Idemitsu Uranium Exploration Canada has an 11.875 percent share, and Reserve Oil and Minerals owns 3.75 percent.

Stanleigh Mine Recommissioned

During 1983 Rio Algom Ltd. recommissioned the Stanleigh mine at Elliot Lake in Ontario. Stanleigh originally provided U_3O_8 to the US government in the latter 1950s and was shut down in 1960. Reactivation of the mine cost $386 million. By year-end the mine had produced approximately 500,000 pounds. The entire output will go to Ontario Hydro, in accordance with a Rio Algom contract to deliver 72 million pounds U_3O_8 between 1983 and 2020. Deliveries were set in 1982 at 770 MTU (approximately 2 million pounds) per year through 2003, with slightly lower deliveries beyond that time.

Export Policy Upheld

After announcing some modifications to its export policy in the third quarter of 1983 the Canadian government reaffirmed the basic provisions with respect to pricing and upgrading. Export contracts must contain a floor price or similar mechanism that protects "investment and employment in uranium production facilities." In the past the pricing policy was more specific in requiring floor prices or annual price negotiations.

The requirement that uranium be exported in its most advanced form (natural UF_6 in Canada) remains in effect. In the past the government has shown a willingness to accommodate particular buyer problems by, for example, approving U_3O_8 export contracts for buyers having conversion commitments outside of Canada. However, the government may be less willing to approve U_3O_8 export contracts in the future. Eldorado Nuclear Ltd., the Canadian government convertor, completed a new facility at Port Hope in 1983, making additional business highly desirable.

Nuclear Power Developments

There are currently twelve Candu reactors operating commercially in Canada, and twelve are under construction or planned (Table 9). Three new units became operational in 1983, New Brunswick EPC's Point Lepreau Unit 1, Ontario Hydro's Pickering Unit 5 and Hydro Quebec's Gentilly 2. In the second half of the year Ontario Hydro experienced a number of problems with pressure tube

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Table 9

COMMERCIAL NUCLEAR REACTORS IN CANADA

Unit	Utility	MWe (net)	Percent Complete	Commercial Operation
Douglas Point	Ontario Hydro	206	100	Sep 1968
Pickering 1	Ontario Hydro	515	100	Jul 1971
Pickering 2	Ontario Hydro	515	100	Dec 1971
Pickering 3	Ontario Hydro	515	100	Jun 1972
Pickering 4	Ontario Hydro	515	100	Jun 1973
Bruce 1	Ontario Hydro	740	100	Sep 1977
Bruce 2	Ontario Hydro	740	100	Sep 1977
Bruce 3	Ontario Hydro	740	100	Feb 1978
Bruce 4	Ontario Hydro	740	100	Jan 1979
Point Lepreau 1	New Brunswick EPC	630	100	Jan 1983
Pickering 5	Ontario Hydro	515	100	May 1983
Gentilly 2	Hydro Quebec	640	100	Dec 1983
Total Operational		7,011		
Under Construction or Planned				
Pickering 6	Ontario Hydro	515	90	Apr 1984
Bruce 6	Ontario Hydro	750	85	Jun 1984
Bruce 5	Ontario Hydro	750	75	Nov 1984
Pickering 7	Ontario Hydro	515	85	Dec 1984
Pickering 8	Ontario Hydro	515	75	Jul 1985
Bruce 7	Ontario Hydro	750	55	Jul 1986
Bruce 8	Ontario Hydro	750	45	Jan 1987
Darlington 2	Ontario Hydro	880	20	May 1988
Darlington 1	Ontario Hydro	880	0	Feb 1989
Darlington 3	Ontario Hydro	880	0	Nov 1991
Darlington 4	Ontario Hydro	880	0	Aug 1992
Point Lepreau 2	New Brunswick EPC	630	6	indefinite
Total Under Construction and Planned		6,630		

[1] CODs from *Nuclear News* World list and other published sources.

cracking that led to the shutting down of Pickering Units 1 and 2 for an indefinite period of time.

The utility shut down Pickering Unit 2 in August following a six foot rupture in one of the unit's pressure tubes that caused a radioactive water leak to reach Lake Ontario. Tube sagging has been a recognized problem for some time; it can cause contact between hot pressure tubes and cold surrounding tubes that indirectly leads to tube wall corrosion and cracking. Pickering Unit 1 was shut down in November for an examination of its tubes, and two of four tubes withdrawn showed signs of cracking. Pickering Units 3 and 4 will be shut down early this year to check for similar problems. While it is not clear when Units 1 and 2 will be operating again, if Ontario Hydro decides that retubing is necessary they could be shut down for two or more years.

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JAPAN

Introduction

Although Japan's nuclear generating plan for the next decade was reduced by more than 10,000 MWe during 1983, the nation's commercial nuclear power program experienced a relatively problem-free year. The 24 commercial units listed in Table 10, which represent a generating capacity of 17,177 MWe, achieved excellent performance records. During 1983 three new units began low power testing (Table 10), while construction on scheduled units proceeded smoothly (Table 11).

Operational Capacity

Japan's commercial nuclear power plants established new records for availability and power generation in 1983. Over a six-month period the 24 units averaged greater than 70 percent availability, and in August, during the period of peak electricity demand for air conditioning, they achieved an 80.6 percent availability record. Nuclear power, which represents only 13 percent of Japan's total electricity generating capacity, accounted for approximately 20 percent of total generation.

Construction and Licensing

Table 11 lists ten units under construction, and seven units currently undergoing licensing, which means they have been approved by Japan's Electric Power Resources Development Coordination Council (EPRDCC). Of those seventeen reactors, scheduled commercial operation dates for seven were delayed six months or more during 1983 due to revisions of load growth forecasts and delays in licensing. Three commercial units received construction licenses during 1983 (Tokyo EPC's Kashiwazaki Units 2 and 5 and Chugoku EPC's Shimane Unit 2); Power Reactor and Nuclear Fuels Development Corporation (PNC) also received a construction license for the Monju 280-MWe Fast Breeder Reactor.

Approval of Kashiwazaki Units 2 and 5 was particularly significant because those units reflect the growing emphasis in Japan on plant standardization. Kashiwazaki Units 2 and 5 basically are duplicates of Tokyo EPC's Fukushima Units II-3 and II-4, which are also under construction. The utility is using the Fukushima engineering designs for the Kashiwazaki units and has standardized components and construction techniques.

Forecast Revisions

In early 1983 the Japanese government maintained an optimistic nuclear generation target of 46,000 MWe by the end of FY1990. Utilities at the time suggested approximately 37,000 MWe as a more realistic target. In October, the Ministry of International Trade and Industry (MITI), which is responsible for government policy for nuclear generation of electricity, drastically reduced the official national target to 34,000 MWe. Three reasons supported the revised target:

1. Greater energy conservation than anticipated;
2. Reduced projections of economic growth;
3. Expected continuation of low and stable oil prices.

Despite reducing the FY90 target for installed nuclear generating capacity, MITI stressed the need for Japan to continue to develop nuclear power aggressively. The official plan calls for the following capacity targets:

FY1990: 34,000 MWe
FY1995: 48,000 MWe
FY2000: 62,000 MWe.

The long-term goals are ambitious, so further revisions are likely in future years.

Uranium Inventories

Cutbacks in Japan's nuclear generation targets have had the effect of increasing the utilities' relative inventory levels and degree of coverage under current contract commitments. Most contracts between Japanese buyers and overseas uranium producers were signed during the 1970s and involve long-term commitments. Contracted quantities were intended to support the optimistic nuclear generation forecasts prevalent at that time. In 1974 the official government plan called for 48,000 MWe of installed nuclear capacity *by 1985*.

The current Japanese uranium supply situation is sufficient to meet the nation's requirements at least through the mid-1990s (Report 179 of July 1983). Existing utility inventories amount to between five and ten years of forward consumption. Although such large inventories are a financial burden under normal circumstances, the Japanese utilities have not expressed much interest in reducing inventory levels or supply commitments. Generally the benefits of long-term security of supply have outweighed potential gains from near-term financial expediency. In addition, because spot market prices are currently far below the prices the utilities are obligated to pay under existing contracts, and because the government must approve any resale of uranium, spot market participation has not seemed particularly attractive to the utilities.

Nevertheless, there were some indications during 1983 that certain Japanese utilities may be prepared to rationalize their uranium procurement programs. Three strategies for accomplishing this objective seem feasible under current conditions.

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Table 10

OPERATIONAL NUCLEAR POWER UNITS: JAPAN

Unit	Utility	Capacity (MWe net)	Type	Commercial Operation
In Commercial Operation				
Tokai 1	JAPC[1]	166	GCR	Jul 1966
Tsuruga	JAPC	357	BWR	Mar 1970
Mihama 1	Kansai EPC[2]	340	PWR	Nov 1970
Fukushima I-1	Tokyo EPC	460	BWR	Mar 1971
Mihama 2	Kansai EPC	500	PWR	Jul 1972
Shimane 1	Chugoku EPC	460	BWR	Mar 1974
Fukushima I-2	Tokyo EPC	784	BWR	Jul 1974
Takahama 1	Kansai EPC	826	PWR	Nov 1974
Genkai 1	Kyushu EPC	559	PWR	Oct 1975
Takahama 2	Kansai EPC	826	PWR	Nov 1975
Fukushima I-3	Tokyo EPC	784	BWR	Mar 1976
Hamaoka 1	Chubu EPC	540	BWR	Mar 1976
Mihama 3	Kansai EPC	826	PWR	Dec 1976
Ikata 1	Shikoku EPC	566	PWR	Sep 1977
Fukushima I-5	Tokyo EPC	784	BWR	Apr 1978
Fukushima I-4	Tokyo EPC	784	BWR	Oct 1978
Tokai 2	JAPC	1100	BWR	Nov 1978
Hamaoka 2	Chubu EPC	840	BWR	Nov 1978
Ohi 1	Kansai EPC	1175	PWR	Mar 1979
Fukushima I-6	Tokyo EPC	1100	BWR	Oct 1979
Ohi 2	Kansai EPC	1175	PWR	Dec 1979
Genkai 2	Kyushu EPC	559	PWR	Mar 1981
Ikata 2	Shikoku EPC	566	PWR	Mar 1982
Fukushima II-1	Tokyo EPC	1100	BWR	Apr 1982
Total in Commercial Operation		17,177		
Fuel Loaded in 1983				
Fukushima II-2	Tokyo EPC	1100	BWR	Feb 1984 (est.)
Onagawa 1	Tohoku EPC	524	BWR	Jun 1984 (est.)
Sendai 1	Kyushu EPC	890	PWR	Jul 1984 (est.)
TOTAL MWe		19,691		

[1] JAPC = Japan Atomic Power Company.

[2] EPC = Electric Power Company.

1. The utilities could negotiate some form of contract relief from present suppliers, for example by reducing annual deliveries and lengthening contract durations.

2. The utilities could adopt a tougher negotiating posture during price negotiations, which under most contracts occur annually for the following year's deliveries.

In recent years the utilities have obtained significant reductions in contract prices because of market price weakness. Prices negotiated in 1983 for 1984 deliveries were in the $33-34 range.

3. The utilities could balance individual inventory levels by exchanging uranium among themselves. Alternately, they might urge the government to establish a national uranium stockpile.

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Table 11

JAPANESE NUCLEAR POWER UNITS UNDER CONSTRUCTION AND UNDERGOING LICENSING

Unit	Utility	Capacity (MWe net)	Type	Estimated Commercial Operation
Under Construction				
Takahama 3	Kansai EPC	870	PWR	Feb 1985
Fukushima II-3	Tokyo EPC	1100	BWR	Jul 1985
Takahama 4	Kansai EPC	870	PWR	Aug 1985
Kashiwazaki 1	Tokyo EPC	1100	BWR	Oct 1985
Sendai 2	Kyushu EPC	890	PWR	Mar 1986
Tsuruga 2	JAPC	1160	PWR	Jun 1987
Hamaoka 3	Chubu EPC	1100	BWR	Sep 1987
Fukushima II-4	Tokyo EPC	1100	BWR	Sep 1987
Kashiwazaki 5	Tokyo EPC	1100	BWR	Apr 1990
Kashiwazaki 2	Tokyo EPC	1100	BWR	Oct 1990
Undergoing Licensing				
Shimane 2	Chugoku EPC	820	BWR	Sep 1988
Kyowa Tomari 1	Hokkaido EPC	579	PWR	Dec 1988
Ikata 3	Shikoku EPC	890	PWR	Oct 1990
Kyowa Tomari 2	Hokkaido EPC	579	PWR	Dec 1990
Genkai 3	Kyushu EPC	1180	PWR	Oct 1991
Maki	Tohoku EPC	825	BWR	Dec 1991
Genkai 4	Kyushu EPC	1180	PWR	Oct 1992
TOTAL MWe		16,443		

Enrichment Services

While the Japanese utilities have contracts with Eurodif to supply approximately one million SWUs per year, they purchase most enrichment services from DOE. The utilities gave considerable attention to DOE's enrichment contract offers during 1983. Those offers included the draft Facility Requirements contract, the Interim Sales contract (ISC), the modified ISC, and the draft Utility Services enrichment contract (USEC). The Japanese did not participate actively in the secondary SWU market during 1983.

Close cooperation between the USA and Japan on trade matters has fostered a stable commitment on the part of the Japanese utilities to DOE. In the early 1970s an agreement between the two nations that aimed to reduce Japan's large trade surplus with the USA enabled Japanese utilities to purchase in advance 8 million SWUs for future deliveries at relatively low prices. By the end of 1983, 4 million of those SWUs remained to be delivered. Most are believed to be included in the terms of the Adjustable, Fixed-commitment (AFC) contracts that make up the majority of enrichment contracts between Japanese utilities and DOE. Therefore, despite considerable efforts by Eurodif and Urenco to attract Japanese enrichment business, DOE will continue to be the dominant supplier. Nevertheless, the Japanese utilities are looking at DOE's recent enrichment offers carefully.

The Japanese government has urged the nuclear utilities to proceed aggressively with the financing of a private company to develop and operate a full-scale centrifuge enrichment plant by the 1990s. Production of 1 million SWUs is planned for 1995 and 3 million SWUs by the year 2000. However, the utilities are unlikely to make the near-term capital investment necessary to fulfill those objectives. Overseas enrichment supplies appear adequate for the foreseeable future, particularly in light of the recently reduced forecasts of installed nuclear generating capacity.

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PNC has been operating a pilot-scale centrifuge enrichment plant (50,000 SWUs per year) at Ningyo-Toge in Okayama Prefecture since March 1982. Preparation is underway for construction at the same site of a demonstration plant having the capacity to produce 200,000 SWUs per year. The first increment of capacity (100,000 SWUs per year) is scheduled to begin operations in 1987, and full capacity operations are scheduled to begin in 1988.

Fuel Reprocessing

As for enrichment, the schedule for a full-scale domestic reprocessing plant is likely to suffer from the 1983 cutbacks in projected nuclear generating capacity. PNC had reprocessed a number of batches of spent LWR fuel using its existing 700 kg per day demonstration plant at Tokaimura, but in 1983 the plant shut down because of dissolver problems. While partial operation may resume early this year, the demonstration plant is unlikely to operate at full capacity for several years. The Japanese nuclear utilities organized Japan Nuclear Fuel Services Company for the purpose of building a 1000 ton per year reprocessing plant modeled on the PNC operation, but the original schedule for commercial operation in the early 1990s is unlikely to be met.

REPUBLIC OF SOUTH AFRICA

Overview

The Republic of South Africa continued to be a stable and reliable uranium producer during 1983 despite economic problems. Low gold and uranium prices in the international markets, severe drought in Southern Africa and cuts in South Africa's nuclear generation plan did not prevent U_3O_8 output from rising, as uranium producers continued their profitable operations.

The passing of a national referendum in November extending voting rights to citizens classified as coloured under South Africa's apartheid laws was interpreted internationally as a positive move by the white electorate. Earlier in the year, the Chamber of Mines recognized black trade unions and union leadership participated in wage negotiations for the first time. There appears to be a feeling within South Africa that closer relations between industry and labor will lead to greater benefits for blacks and a more stable workforce for the mining industry.

While some encouraging developments occurred during 1983, conflicts between South Africa and neighboring Angola and Mozambique pointed up the continuing political difficulties of Southern Africa in general. The growth in size of the outlawed African National Congress (ANC), and what seemed to be greater international recognition and support for the group, raised some questions internationally about the duration of relative political and economic stability.

Nuclear Power

The Electricity Supply Commission of South Africa (Escom) concluded in its 1983 review of generation expansion plans that no nuclear units other than the twin Koeberg PWRs near Capetown are likely to be operational before the end of the century. The Koeberg plant, which was in the final stages of construction late in 1982 when an ANC bomb exploded at the site, should begin to produce electricity during 1984. Other plans for nuclear plants have been scrapped primarily because of low coal costs and declining demand for electricity.

Escom currently has under construction several coal-fired generating stations that will fill electricity demand in the country's interior well into the coming century. Coal is remarkably inexpensive in the South African interior. Nuclear power stations along the coast could be competitive with coal stations because of high coal transportation costs, but electricity demand on the coast comprises only 25 percent of the country's total. Furthermore, electricity growth rates dropped substantially during 1982 and 1983, from a previous annual average of approximately 7 percent to approximately 2 percent.

Uranium Production

The South African uranium production industry managed to do well in 1983 despite low dollar prices for gold and uranium concentrates. All uranium-gold facilities continued profitable operations. Four general factors help to explain the stability of the industry.

1. Long-term uranium contracts concluded in previous years continued to absorb production, and while prices under long-term contracts may have declined somewhat during 1983, they remained well above spot market prices.

2. South Africa's contracts customarily are denominated in US dollars, so the declining Rand/US Dollar currency exchange rate acted to mitigate some of the effects of depressed worldwide demand for uranium.

3. Most South African producers have the flexibility to vary grades and throughput to meet particular operational and market circumstances.

4. By-product and co-product uranium production from gold mining in general costs less than primary uranium production.

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Table 12 shows a breakdown of uranium production among thirteen operations in South Africa during 1983 (the figures for Palabora Mining Company (PMC) are not yet available). Total production, excluding PMC, of 15.3 million pounds U_3O_8 in 1983 exceeded by 5 percent the 1982 level of 14.6 million pounds. For five producers output declined from 1982 levels; JMS alone cut production by 317 thousand pounds. However, eight producers increased production. More than 75 percent of the increases came from three operations: Beisa (up 443 thousand pounds), Vaal Reefs (up 334 thousand pounds), and Western Areas (up 247 thousand pounds). The Western Areas and Beisa mines are relatively new operations building up production. Actual 1983 production from South Africa was 1.6 percent higher than Nuexco's forecast of 15.0 million pounds U_3O_8 excluding PMC.

Specific Comments on Production Operations

Beisa (St. Helena). The Beisa uranium gold mine, which St. Helena Gold Mines Ltd. purchased in 1980, increased U_3O_8 production by 79 percent in 1983. Output during 1982, the first full year of production, had been hampered by numerous intersections of water. Rated capacity of 220 million pounds of ore per month nearly was achieved in the fourth quarter of 1983.

Blyvooruitzicht. Production in the fourth quarter fell by 28 percent as lower-grade surface slimes were processed. Nevertheless, total 1983 U_3O_8 production increased 15 percent over 1982. By-product uranium output may continue into 1985 until the U_3O_8 stockpile is sufficient to supply outstanding contract commitments. The operators are considering more profitable stockpile options than production, however, which means plant operation may cease within the year.

Buffelsfontein. Fourth quarter production and annual production both rose 5 percent due to mining of higher grade ore. In the fourth quarter construction was completed on the 440 million pound per month sub-vertical shaft system to the Lucas block area of the deposit. Buffelsfontein now owns a 20 percent stake in Chemwes.

Chemwes (Stilfontein). Stilfontein Gold Mining Ltd. is the parent company of Chemwes, which produced 7 percent less U_3O_8 in 1983 than in 1982. The decrease was attributed to treatment of lower grades pursuant to the depletion of higher grade slimes from Buffelsfontein.

Driefontein. Processing of higher grade ore increased U_3O_8 output 28 percent in the fourth quarter, but failed to make up for lower grades processed during mid-year. Annual production dropped 22 percent from the 1982 level. Driefontein is a rich, long-life mine that has the flexibility to achieve high grades in times of low gold prices.

Table 12

**REPUBLIC OF SOUTH AFRICA:
1983 URANIUM PRODUCTION
(Thousands of Pounds U_3O_8)**

Operation	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Total 1983
Beisa (St. Helena)	198	233	267	305	1,003
Blyvooruitzicht	149	185	180	127	641
Buffelsfontein	304	342	337	362	1,345
Chemwes (Stilfontein)	268	297	320	360	1,245
Driefontein Consolidated	108	88	85	105	386
ERGO[1]	143	134	124	106	507
Harmony	366	363	335	310	1,374
Hartebeestfontein	234	241	252	246	973
JMS[2]	371	384	411	420	1,586
Randfontein	270	262	270	281	1,083
Vaal Reefs	1,018	1,083	1,042	996	4,139
Western Areas	132	158	170	164	624
Western Deep Levels	94	94	107	89	384
TOTALS	3,655	3,864	3,900	3,871	15,290

[1] ERGO = East Rand Gold and Uranium Co. Ltd.
[2] JMS = Free State Joint Metallurgical Scheme.

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East Rand Gold and Uranium Co. Ltd. (ERGO). Fourth quarter and annual production declined 15 percent and 13 percent respectively after higher grade slime reserves were depleted. New dams with lower grade ore have led to lower production rates. The new Simmergo treatment plant began operating in 1983.

Harmony. Annual production rose 6 percent in 1983 to set a record for U_3O_8 output. Because Harmony is among the largest gold mines, it has remained profitable even when processing very low grade ore. However, the company has indicated that U_3O_8 production may be curtailed unless spot prices show signs of improvement.

Hartebeestfontein. Production remained constant throughout 1983 from this stable producer.

Free State Joint Metallurgical Scheme (JMS). U_3O_8 output for the fourth quarter remained constant, but annual production fell 17 percent as a result of continued changes to the feed mix and reductions in the grade of slimes treated during the year.

Randfontein. Production for the fourth quarter rose 4 percent and for the year rose 6 percent as tonnage throughput increased following extensions to the uranium section of the Cooke plant, which now has a throughput capacity of 300 thousand tonnes per month. Randfontein acquired mining rights in 1983 to an area northeast of Cooke known as Doornkop, and began planning for a major expansion that includes 50 thousand tonnes per month additional capacity at the Cooke plant by mid-1985.

Vaal Reefs. Fourth quarter production fell 4 percent due to lower grades treated from the North Lease area and lower tonnage treated from the South Lease area. 1983 production rose 9 percent, however, as higher grades from the South Lease area contributed more to the operation overall. Profits from U_3O_8 sales jumped 182 percent in the final quarter (to R26.8 million) and 83 percent, to R55.5 million, for the year. Vaal Reefs consistently shows higher uranium profits in the fourth quarter because of contract delivery schedules. Profits for the year are the highest since 1979 (R61.8 million), indicating significant new sales in 1983.

Western Areas. While fourth quarter production changed little, output for the year increased 66 percent over 1982, reflecting the new plant's build-up to rated capacity.

Western Deep Levels. Throughput in general dropped during 1983, bringing production down five percent from 1982. Fourth quarter production dropped 17 percent as both grade and tonnage levels fell. Western Deep Levels continued work on a major expansion in the south of the lease area during 1983.

UNITED STATES

Introduction

US utility nuclear power programs in general had a difficult year in 1983, as did the US uranium production sector. Financial and regulatory problems plagued nuclear plant construction as they have for several years. A sense of recovery or stabilization seemed to characterize the first half of the year, but at year-end renewed pessimism emerged. The failing health of many US nuclear power programs reflected back on the nuclear fuel market and domestic uranium activities. Several producers reduced production and four facilities were shut down altogether.

Nuclear Power

Construction delays and financial difficulties altered several utilities' long-range forecasts for commercial operation during 1983. Sixteen units were delayed for at least one year, two were deferred indefinitely (tantamount to cancellation) and seven were cancelled outright (Table 13). (While the official announcement of Public Service of Indiana's cancellation of its two Marble Hill units came in January 1984, the action was evident in December 1983.) The total generating capacity cancelled amounted to 7,923 MWe, one-fourth the amount cancelled in 1982. Nuexco estimates that at least 13 additional reactors now under construction or on order eventually will be cancelled. Those cancellations, if they take place, will remove approximately 15,220 MWe of generating capacity and approximately 4.3 million pounds U_3O_8 of potential average annual consumption from the portion of the US nuclear power base once thought secure.

While the general climate for nuclear plant construction did not improve markedly during 1983, four reactors, representing a total capacity of 3,727 MWe, did begin commercial operation during the year. In addition, one fuel loading and low power testing license, two low power operating licenses and two full power operating licenses were issued, adding 5,442 MWe to US nuclear generating capacity. Table 14 summarizes the licensing progress of US nuclear units during 1983.

Table 15 lists US reactors under construction in descending order of completion percentage, as of December 31, 1983. A survey by the Atomic Industrial Forum indicated that 14 reactors may receive operating licenses during 1984, representing a total of 15,544 MWe.

Legislation Regarding Uranium

Faced with weak prices and little demand, US producers continued to seek relief from the US government, asking Congress to reimpose limitations on the import of

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Table 13
US NUCLEAR UNITS DELAYED, DEFERRED AND CANCELLED IN 1983

Unit	Utility	MWe (net)	Type	Delay From	Delay To	Months Delayed
Delayed at least one year						
Grand Gulf 1	Middle South	1250	BWR	2/83	9/84	19
Waterford 3	Louisiana P&L	1104	PWR	7/83	12/84	17
Fermi 2	Detroit Ed.	1100	BWR	11/83	12/84	13
Shoreham	LILCO	820	BWR	3/83	1/85	22
Perry 1	Cleveland Elec.	1205	BWR	5/84	5/85	12
Palo Verde 1	Arizona PS	1270	PWR	5/83	10/85	29
Seabrook 1	PS New Hampshire	1150	PWR	2/84	12/85	22
Palo Verde 2	Arizona PS	1270	PWR	5/84	1/86	20
Midland 1	Consumers Power	530	PWR	7/84	6/86	23
Midland 2	Consumers Power	805	PWR	12/83	6/86	30
Clinton 1	Illinois Power	933	BWR	8/84	11/87	39
Seabrook 2	PS New Hampshire	1150	PWR	5/86	12/87	19
Bellefonte 2	TVA	1213	PWR	11/86	11/88	24
South Texas 2	Houston L&P	1250	PWR	- 86	6/89	30
Carroll County 1	Comm. Edison	1120	PWR	- 99	2001	12+
Carroll County 2	Comm. Edison	1120	PWR	2000	2002	12+
Indefinitely Deferred						
Zimmer	Cincinnati G&E	810	BWR	- 84	indefinite	
WNP3	WPPSS	1240	PWR	12/86	indefinite	
TOTAL MWe Delayed and Deferred		19,340				
Cancelled					**Percent Complete**	
Marble Hill 1	PS Indiana	1130	PWR		55	
Marble Hill 2	PS Indiana	1130	PWR		35	
Cherokee 1	Duke Power	1280	PWR		18	
Harris 2	Carolina P&L	900	PWR		4	
Clinton 2	Illinois Power	933	BWR		0	
Skaget-Hanford 1	Puget Sound P&L	1275	BWR		0	
Skaget-Hanford 2	Puget Sound P&L	1275	BWR		0	
TOTAL MWe Cancelled		7,923				

non-US uranium. Their efforts resulted in new legislation which provides for a periodic review of the viability of the US uranium mining industry. The purpose of the review, however, is to ensure the national security of the USA rather than the prosperity of the domestic uranium industry.

Based on the legislation, the Energy Information Administration (EIA) of the US Department of Energy (DOE) will compile an annual report on the US uranium industry for submission to the Secretary of Energy. EIA has published a number of criteria that will be used in assessing the viability of the industry. These include:

1. the current extent of US uranium resources;
2. US producer supply response capabilities based on current uranium production activities;
3. financial capabilities of US uranium producers;

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Table 14
US NUCLEAR UNITS NEARING COMMERCIAL OPERATION IN 1983

Unit	Utility	MWe net	Type	COD[1]
Commercial Operation				
Susquehanna 1	Penn. P&L	1050	BWR	Jun 1983
San Onofre 2	So. Cal. Ed.	1000	PWR	Aug 1983
St. Lucie 2	Florida P&L	777	PWR	Aug 1983
Summer 1	So. Carolina E&G	900	PWR	Jan 1984
Full Power Operating Licenses				
McGuire 2	Duke	1180	PWR	Jun 1984
San Onofre 3	So. Cal. Ed.	1000	PWR	Dec 1984
Low Power Operating Licenses				
LaSalle 2	Comm. Edison	1078	BWR	Dec 1984
WNP 2	WPPSS	1100	BWR	Dec 1984
Fuel Loading and Low Power Testing Licenses				
Diable Canyon 1	Pacific G&E	1084	PWR	Jun 1984
TOTAL MWe		9,169		

[1] Commercial Operating Date, based on published information and utility forecasts.

4. the strength and reliability of non-US supply commitments to the USA.

It appears doubtful that the new legislation will have any near-term impact on sales of non-US origin uranium to US utilities.

Uranium Production

US uranium production declined from 26.8 million pounds in 1982 to approximately 20.6 million pounds during 1983. Relatively low spot prices forced several producers to scale back production. Four facilities, representing a total production capacity of approximately 5.5 million pounds U_3O_8 per year, either closed permanently or shut down pending a rise in prices. Some of those closures followed completion of older contracts signed at high prices, and subsequent failure to conclude new contracts on economical terms.

A number of large multinational firms continued a recent trend by exiting the uranium production business and disposing of their uranium properties. Concurrently, a number of smaller organizations acquired uranium holdings. Low prices and weak demand affected particularly the larger, capital-intensive developments typically undertaken by large organizations. By focusing on smaller projects, smaller firms have shown an ability to produce at lower costs and to respond more rapidly to the market.

Outlook for 1984

The trends evident in 1983 are likely to persist in 1984, as the US nuclear power program continues to combat financial and regulatory obstacles and as excesses of uranium and fuel cycle services continue to be liquidated into an already glutted market. With additional plant cancellations, and with production exceeding consumption worldwide, it seems likely that 1984 will witness a continuation of the current buyer's market for all materials and services in the front end of the fuel cycle.

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Table 15

US NUCLEAR UNITS UNDER CONSTRUCTION AND ON ORDER

Unit	Utility	MWe (net)	Type	Percent Complete	COD[1]
Grand Gulf 1	Middle South	1250	BWR	99	Sep 1984
Palo Verde 1	Arizona PS	1270	PWR	99	Oct 1985
Zimmer 1	Cincinnati G&E	810	BWR	98	indefinite
Waterford 3	Louisiana P&L	1104	PWR	98	Dec 1984
Palo Verde 2	Arizona PS	1270	PWR	98	Jan 1986
Comanche Peak 1	Texas Utilities	1150	PWR	96	Dec 1984
Watts Bar 1	TVA	1177	PWR	95	Jul 1984
Fermi 2	Detroit Edison	1100	BWR	95	Dec 1984
Catawba 1	Duke Power	1145	PWR	94	Jun 1985
Susquehanna 2	Penn. P&L	1050	BWR	92	Nov 1984
Diablo Canyon 2	Pacific G&E	1106	PWR	91	Nov 1984
Shoreham	Long Island Lighting	820	BWR	90	Jan 1985
Callaway 1	Union Electric	1150	PWR	90	Jan 1985
Wolf Creek	Kansas G&E	1150	PWR	87	Feb 1985
Byron 1	Commonwealth Edison	1120	PWR	86	Feb 1984
Limerick 1	Phil. Electric	1055	BWR	86	Apr 1985
Midland 1	Consumers Power	530	PWR	85	Jun 1986
Midland 2	Consumers Power	805	PWR	85	Jun 1986
Perry 1	Cleveland Electric	1205	BWR	84	May 1985
Bellefonte 1	TVA	1213	PWR	83	Nov 1988
Clinton 1	Illinois Power	933	BWR	81	Nov 1987
Seabrook 1	PS New Hampshire	1150	PWR	81	Dec 1985
Shearon Harris 1	Carolina P&L	900	PWR	79	Mar 1986
WNP 3	WPPSS	1240	PWR	75	indefinite
Millstone 3	Northeast Utilities	1150	PWR	72	May 1986
Hope Creek 1	PS Electric & Gas	1170	BWR	71	Dec 1986
River Bend 1	Gulf States Utilities	940	BWR	71	Dec 1985
Nine Mile Pt. 2	Niagara Mohawk	1080	BWR	70	Oct 1986
Byron 2	Commonwealth Edison	1120	PWR	69	Feb 1985
Braidwood 1	Commonwealth Edison	1120	PWR	68	Oct 1985
Beaver Valley 2	Duquesne	833	PWR	68	May 1986
Palo Verde 3	Arizona PS	1270	PWR	65	Oct 1986
Comanche Peak 2	Texas Utilities	1150	PWR	63	Dec 1985
Bellefonte 2	TVA	1213	PWR	63	Nov 1988
WNP 1	WPPSS	1250	PWR	63	indefinite
Watts Bar 2	TVA	1177	PWR	56	Jan 1986
Braidwood 2	Commonwealth Edison	1120	PWR	53	Oct 1986
Catawba 2	Duke Power	1145	PWR	52	Jun 1987
Vogtle 1	Georgia Power	1100	PWR	51	Mar 1987
South Texas 1	Houston L&P	1250	PWR	47	Jun 1987
Hartsville A1	TVA	1233	BWR	44	indefinite
Perry 2	Cleveland Electric	1205	BWR	38	May 1988
Hartsville A2	TVA	1233	BWR	34	indefinite
Limerick 2	Phil. Electric	1055	BWR	30	Oct 1988
Grand Gulf 2	Middle South	1250	BWR	25	indefinite
Seabrook 2	PS New Hampshire	1150	PWR	23	Dec 1987
South Texas 2	Houston L&P	1250	PWR	23	Jun 1989
Vogtle 2	Georgia Power	1100	PWR	16	Sep 1988
Carroll County 1	Commonwealth Edison	1120	PWR	0	2001
Carroll County 2	Commonwealth Edison	1120	PWR	0	2002
River Bend 2	Gulf States Utilities	940	BWR	0	indefinite

[1] Commercial Operating Date, based on published information and utility forecasts.

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US URANIUM ACTIVITIES

Introduction

The steady decline in uranium mining and exploration that occurred in 1982 continued during 1983, as the market for U_3O_8 failed to show a strong recovery. A brief market turnaround in fourth quarter 1982 and first half 1983, which followed spot market lows near $17, led to some stabilization of uranium activities. However, a year-end price downturn reinstituted further curtailment.

Total US U_3O_8 production dropped more than five million pounds from 1982, to an estimated 20.6 million pounds. Two production centers shut down in the first quarter of 1983. As a moderate price recovery seemed to be underway by mid-year, two milling operations that had been idle for a year or more resumed production on a limited basis. However, a third production center closed in October, and a fourth in December, and fourth quarter output was the lowest of 1983.

Nuexco estimates exploration and development drilling for the year at 3.0-3.5 million feet, down 45 to 50 percent from the 6.1 million feet drilled in 1982. The drilling rate was down in all areas of activity for the third straight year. Estimated 1983 drilling was approximately 93 percent below the record high of 47 million feet drilled in 1978. If the present drilling trend continues, the level of activity for 1984 may approach the low of 1.6 million feet drilled in 1952.

Active Projects

The main area for exploration activity during 1983 was once again to the north and south of Grand Canyon National Park, in the **Arizona Strip** (see Reports 163 and 176). Five companies conducted geophysical and geochemical programs and drilling in the search for uranium-bearing breccia pipes.

Energy Fuels Ltd. was most active, having nearly one million acres under control for exploration and mining purposes. It is the only company actually producing in the district. The company has four operating mines and a permit from the US Department of Interior to drill an exploration shaft on a fifth mineralized structure. The nature of mineral occurrence in breccia pipes is such that full evaluation by drilling from the surface can be an extremely difficult and expensive process. The exploration shaft will permit access to the ore zone for complete evaluation by underground drafting and drilling.

Further exploration and development activity was concentrated along known geologically favorable mineralized trends in various areas, including Duval, Brooks, and Kleberg counties in the **South Texas district.** Uranium Resources, Inc. outlined significant mineralization on its Kingsville Dome property near Kingsville in Kleberg County, and is planning to develop an in situ leach (ISL) recovery project in the near future. Everest Minerals Corporation installed an ISL pilot test at Mt. Lucas in Live Oak County, Texas in August, upgrading it to a commercial plant in November.

Continued exploration along the **Crow Butte** uranium trend in northwestern Nebraska succeeded in extending mineralization over a distance of at least 20 miles. Following the 1980 discovery of the Crow Butte uranium deposit near Crawford, Ferret Exploration Company independently initiated its Big Red exploration program in nearby areas of Dawes and Box Butte counties. Drilling during 1983 resulted in the apparent discovery of a major roll front uranium deposit. Important uranium reserves were identified over a trend-length of about 1.5 miles. The deposit represents the southward continuation of the Crow Butte trend. Ferret presently controls over 42,000 acres for exploration and mining in the area of interest.

The Crow Butte Joint Venture (owned half each by Wyoming Fuel Company and Ferret Exploration Company) determined that the Crow Butte deposit is amenable to solution mining techniques. The Joint Venture anticipates completion of licensing and permit procedures in early 1984, followed by construction and operation of a pilot solution mine and plant. Commercial production is anticipated in 1987.

The Commonwealth of Virginia evaluated an industry report on the benefits of developing the **Swanson Uranium Project** in Pittsylvania County The evaluation concluded that a uranium development program by Marline Uranium Corporation, the lessee, could be carried out favorably within the guidelines of a well conceived and well implemented regulatory program. A special task force comprised of heads of various state agencies probably will propose regulatory guidelines in a study that is scheduled to be completed by late 1984.

Atlas Corporation of Moab, Utah announced further drilling success at its Bullfrog property located in **Southeastern Utah.** Uranium resources are sufficient to consider mining, according to Atlas management. Project feasibility studies indicate underground development would be compatible with the company's long-term uranium program. However, additional evaluation of the ore deposit remains to be completed prior to undertaking project development.

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Homestake Mining Company entered into an option agreement to earn a 50 percent interest in an ore deposit located near its mill at Ambrosia Lake, **New Mexico.** If the option is exercised, Homestake will finance and operate an underground mine. The property owner is Midas International Inc. of Pasadena, California and Milan, New Mexico. Mine development could begin by mid-1984 and ore production by late 1985 or early 1986.

With the exception of Everest Minerals' ISL plant in South Texas, almost no new projects commenced commercial operations during 1983. The Everest ISL pilot test on its Mt. Lucas property was a technical and economic success from the start. Production reached a commercial level of 1600 gallons per minute by late November. The plant is operating at full capacity and uranium recovery is at the level anticipated by Everest.

Other significant announcements and events that affected the US uranium industry in 1983 are listed chronologically in Table 16.

Table 16

1983 URANIUM RELATED ACTIVITIES IN THE USA

Month	Company/Entity	Event or Announcement
Jan	Energy Fuels	Suspended mill operations at White Mesa, near Blanding, Utah.
Mar	Everest Minerals	Purchased Exxon's Highland ore deposit, plus mine and mill buildings, Powder River Basin, Wyoming.
Mar	Minerals Expl. Co.	Announced plan to suspend production at its Sweetwater Project, Red Desert, Wyoming.
Mar	Homestake	Announced 2 month shut-down of its Grants, New Mexico mill, as of May 26.
Mar	Mobil	Received final approval from New Mexico EID agency for a new processing plant at Crownpoint, New Mexico.
Apr	US DOE	Announced 1982 U_3O_8 production was 26.9 million pounds at average grade of 0.12 percent.
Apr	Wyoming Mineral	Purchased Conoco's 50 percent interest in the Crownpoint, New Mexico project.
Apr	US Interior Dept.	Initiated litigation against Dawn Mining Co. over mining plans at the Midnight mine, Wellpinit, Washington.
Apr	Rocky Mt. Energy	Announced study in progress for open pit mining of four deposits in Weld County, Colorado. Milling would be done at Bear Creek, Powder River Basin, Wyoming.
May	Union Carbide	Announced intent to reopen the Uravan mill on a temporary schedule.
Jun	Pathfinder Mines	Started underground development off the south wall of the 2R South pit, Gas Hills district, Wyoming.
Jun	Minerals Expl. Co.	Suspended operations at its Sweetwater Project, Red Desert, Wyoming.
Jun	Conoco	Sold its Ruby Ranch project in the Powder River Basin, Wyoming, to Santa Fe Mining Inc.
Jun	Conoco	Closed its Denver-based minerals division.
Jun	Energy Fuels	Received authorization from the Interior Department to drill an exploration shaft on the Kanab North breccia pipe, Arizona Strip area.
Jul	Mobil	Mobil Alternative Energy, Inc., formed to administer all activities for uranium and other minerals.

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1983 URANIUM RELATED ACTIVITIES IN THE USA

Month	Company/Entity	Event or Announcement
Aug	Homestake	Will close the Pitch mine at year-end.
Aug	Homestake	Negotiating joint venture project near Grants, New Mexico with Midas International, Inc.
Aug	Rio Algom	Purchased the Mi Vida mine near La Sal, Utah. Production to resume in a few weeks.
Aug	Homestake	Increased production at the Grants, New Mexico mill from 17,000 tons per month to 25,000 tons.
Aug	Everest Minerals	Started up ISL pilot operation at its Mt. Lucas project, South Texas district.
Aug	AGIP Nucleaire	Announced plans to develop the Juniper Ridge deposits near Baggs, Wyoming.
Sep	Exxon Nuclear	To extend mine and mill operations at Highland, Wyoming until end of first quarter, 1984.
Oct	US DOE	Transferred the uranium industry viability study program from Grand Junction, Colorado to the Energy Information Administration in Washington, D.C.
Oct	Union Carbide	Closed its Uravan mill for an indefinite period.
Oct	Cotter Corp.	Announced tentative plan to start-up two or more mining operations in the Naturita, Colorado area.
Oct	Intercont. Energy	Acquired the mineral rights from Exxon for the tailings pond at Ray Point, Texas.
Oct	Kerr McGee	Reorganized its nuclear operations into two companies. All New Mexico operations to operate as Quivira Mining Co. All other nuclear-related operations to be known as Sequoyah Fuels Corp.
Oct	Union Carbide	Ninety-three employees were dismissed from the Uravan and Rifle, Colorado mills.
Oct	Homestake	Closed the Pitch mine about two months ahead of schedule.
Nov	Homestake	Formed Wind River Mining Co. for participation in a 50-50 joint venture with Rich Mining Co. to mine the Midas deposit near Grants, New Mexico.
Nov	Intercont. Energy	Announced plans to purchase the Lamprecht ISL project in South Texas from Wyoming Mineral Corp.
Nov	Rio Algom	Increased production at the Lisbon mill to 750 tons per day, 7 days per week.
Nov	Homestake	Dismissed forty employees at Grants, New Mexico operations.
Nov	Union Carbide	Dismissed 100 miners in the Uravan, Colorado mining district.
Nov	Atlas Corp.	Study in progress for mining the Bullfrog deposit in Southeastern Utah.
Dec	Union Carbide	Has lease agreement with Energy Fuels for 70 percent of capacity on the Blanding, Utah mill which may reopen in late 1984.
Dec	Union Carbide	Gas Hills, Wyoming mine and mill placed on standby, 104 employees dismissed.
Dec	Uranium Resources	Entered into joint venture exploration and mining program with a non-US company in the South Texas district.

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WORLD URANIUM PRODUCTION

Continuing a trend begun in 1982, world uranium production declined in 1983 by 7 percent from the previous year, to approximately 96 million pounds. Production declines in the USA, Australia and Canada more than offset increases in output from Africa, France and other regions. A comparison of Nuexco's production estimates for 1982 and 1983 is presented in Table 17.

Table 17

1983 WORLD URANIUM PRODUCTION
(millions of pounds U_3O_8)[1]

Country	1982	1983	Percent Change
Australia	11.6	8.4	-28
Canada	20.1	19.0	-5
France	6.6	8.5	+29
South Africa[2]	15.1	15.8	+5
Other Africa	20.9	21.2	+1
Other	1.6	2.3	+44
Subtotal	75.9	75.2	-1
United States	26.8	20.6	-23
TOTAL (rounded)	103.0	96.0	-7

[1] Nuexco estimates.
[2] Includes estimate for Palabora Mining Company.

South Africa was the only major producer country to show production increases during 1983 (see the *Annual Review* of South Africa in this Report). Production in Central Africa grew slightly, contrary to previous expectations. France brought Lodeve to capacity, thus showing growth in uranium output for a second year. With Brazil's Pocos de Caldas reaching capacity, the other countries category also showed a marked increase in production.

Australia, Canada and the USA all decreased output during 1983. Australian output declined because of the absence of production from Mary Kathleen, which was shut down late in 1982, and because Ranger closed down in the fourth quarter due to labor union problems. Canadian production declined despite the commissioning of Key Lake and the reopening of the Stanleigh mine because of the phasing out of older operations. US production declined for the third year in a row. The greatest cutbacks were in conventional mining, with in situ and by-product operations continue to be strong. The regional distribution of US production is shown in Table 18.

Table 18

US URANIUM PRODUCTION BY STATE
(millions of pounds U_3O_8)[1]

Mill Location	1983	Percent of Total 1983 Production
Wyoming	5.4	26
New Mexico	5.1	25
Texas	3.2	15
Utah	2.0	10
Others	4.9	24

[1] Nuexco estimate.

Nuexco anticipates an increase in world production in 1984. Canada's Key Lake is expected to reach its 12 million pounds U_3O_8 annual capacity by year end; Stanleigh will also increase output. Ranger in Australia should produce at capacity without interruption. As indicated in Table 19, a 6 percent increase is anticipated, with the only substantial decline in the USA.

Table 19

1984 WORLD PRODUCTION FORECAST
(millions of pounds U_3O_8)[1]

Country	1983	1984	Percent Change
Australia	8.4	10.5	+25
Canada	19.0	28.1	+48
France	8.5	8.0	-6
South Africa	15.8	16.2	+3
Other Africa	21.2	20.3	-4
Other	2.3	2.4	+4
Subtotal	75.2	85.5	+14
United States	20.6	16.0	-23
TOTAL (rounded)	96.0	102.0	+6

[1] Nuexco estimates.

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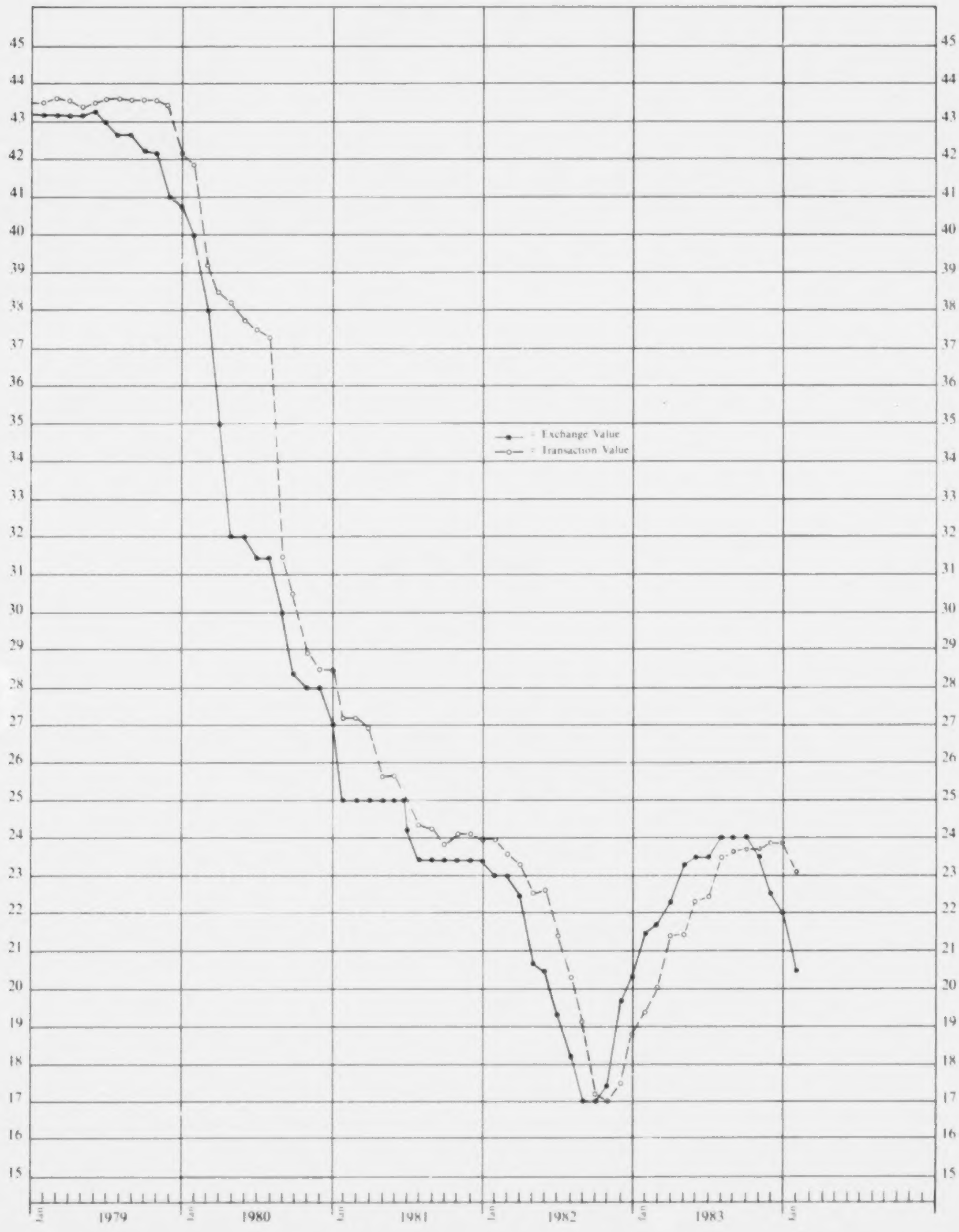
HISTORICAL MARKET DATA

EXCHANGE AND TRANSACTION VALUES
SINCE JANUARY 1979

Determined as of the last day of the month indicated



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HISTORICAL MARKET DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00
1984	**20.50**											

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85
1984	**23.05**											

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60
1984	**0.60**											

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GOVERNMENT STATISTICS

AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage Earners, Weekly Rates[2] (1976=100)
1972 Avg.	105.6	71.3
1973 Avg.	124.4	79.0
1974 Avg.	141.9	108.1
1975 Avg.	150.4	132.6
1976 Avg.	168.4	160.9
1977 Avg.	192.0	179.0
1978 Avg.[3, 4]	198.5	190.0
1979 Avg.	248.8	127.9
1980 Avg.	321.8	140.8
1981 Avg.	355.3	154.1
1982 Avg.[5]	368.6	174.9
Oct 1982	378.5	178.4
Nov 1982	375.9	178.5
Dec 1982	374.9	179.5
Jan 1983	385.7	179.6
Feb 1983	387.5	179.8R
Mar 1983	397.4	179.7R
Apr 1983	407.3	180.0R
May 1983	414.8	180.1R
Jun 1983	415.6	180.2R
Jul 1983	408.4	179.9R
Aug 1983	403.1	179.8R
Sep 1983	403.1	179.7R
Oct 1983	—	186.8R
Nov 1983	—	186.6P

P = Preliminary R = Revised since last month

[1] Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0).

[2] Australian Bureau of Statistics, Canberra: "Award Rates of Pay Indexes, Australia" (Catalogue No. 6312.0). Figures for the latest fourteen months shown are subject to revision.

[3] Monthly data for 1970-78 appear on pages 4.7 and 4.8 of Report 138.

[4] Annual averages prior to 1979 reflect index base no longer in use.

[5] Monthly data for 1979-82 appear on page 35 of Report 184.

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GOVERNMENT STATISTICS

CANADA

	Industry Selling Price Index: Manufacturing[1] (1971=100)	Wage-earner Data: Average Hourly Earnings (C$)[2]						
		Uranium Mines (SIC 057)	Metal Mines (SIC 051-059)	Mines, Quarries and Oil Wells[3] (SIC 051-099)	Primary Metal Industries Non-ferrous[4] (SIC 296)	Primary Metal Industries Non-ferrous[4] (SIC 296-298)	Primary Metal Industries Non-ferrous[4] (SIC 298)	Chemicals and Chemical Products[5] (SIC 370-379)
1979 Avg.[6]	217.9	—	9.60	9.66	—	7.35	—	7.67
1980 Avg.	247.2	—	10.59	10.80	—	8.05	—	8.50
1981 Avg.	288.7	—	12.02	12.23	—	9.03	—	9.53
1982 Avg.[7]	288.8	—	13.74	13.92	—	9.98	—	10.63
1983 Avg.	298.7P	—	—	—	—	—	—	—
Oct 1982	292.1	—	13.83	13.89	—	10.18	—	10.86
Nov 1982	291.3	—	14.42	14.28	—	10.43	—	10.90
Dec 1982	292.3	—	14.54	14.32	—	10.55	—	11.06
Jan 1983	292.7	—	14.36	14.35	—	10.72	—	11.06
Feb 1983	293.5	—	14.24	14.28	—	10.74	—	11.06
Mar 1983[8]	295.2	16.79	14.84	14.48	—	10.93	—	11.21
Apr 1983	297.1	16.83	14.40	14.13	11.57	—	10.10	11.02
May 1983	298.5	17.02	14.50	14.10	11.39	—	9.82	10.97
Jun 1983	299.3	17.02	14.60	14.07	11.33	—	9.84	11.05
Jul 1983	300.4	16.48	14.35	13.93	11.70	—	9.83	11.04
Aug 1983	301.2	16.93	14.36	13.89	11.82	—	10.08	11.19
Sep 1983	301.0R	17.66	14.90	14.41	11.99	—	10.38R	11.29
Oct 1983	301.5R	17.73	15.27	14.65R	11.76R	—	10.03R	11.30R
Nov 1983	301.6R	16.07P	14.83P	14.49P	11.68P	—	10.60P	11.46P
Dec 1983	302.7P	—	—	—	—	—	—	—

P = Preliminary R = Revised since last month

[1] Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (Catalogue 62-011). Indexes for the most recent six months shown are subject to revision.

[2] Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours" (Catalogue 72-002).

[3] Reports 175 through 185 list this series title incorrectly as "Metal Mining, Including Milling (SIC 050-099)".

[4] Beginning with the April 1983 figure, Primary Metal Industries, non-ferrous is split into SIC 296 and SIC 298.

[5] Chemical and Chemical Products prior to April 1983 was SIC 370-379. The new series is from a new survey which includes all companies and is based on a 1970 classification. The old survey only included companies of 20 employees or more.

[6] Monthly ISPI for 1977 and 1978 appear on page 4.10 of Report 138; and monthly wage-earner data for 1973-78 appear on page 4.11 of Report 138.

[7] Monthly data for 1979-1982 appear on page 37 of Report 184. On that page, the wage earner index entitled "Metal Mining, Including Milling (SIC 050-099)" should read "Total Mining (SIC 051-099)".

[8] Beginning with the March 1983 figure, Wage Earner Data are based on a census of all companies employing 200 or more wage earners, *plus* a random survey of companies employing fewer than 200 wage earners. Prior to March 1983 only companies employing fewer than 200 wage earners are included in the Wage Earner Data.

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REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100)	Producer Price Index All Groups[4] (1975=100)[3]	Total Employment in Mining and Quarrying (Code 35)[5]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[5]
1972 Avg.	8.79	113.3	63.9	623,067	443,933
1973 Avg.	10.51	124.1	72.3	684,743	572,133
1974 Avg.	13.18	138.5	85.3	674,140	761,596
1975 Avg.	16.71	157.2	100.0	639,473	1,003,617
1976 Avg.	19.30	174.7	115.1	671,240	1,212,983
1977 Avg.	23.87	194.4	130.0	712,006	1,420,670
1978 Avg.	27.14	137.2	142.7	664,571	1,537,169
1979 Avg.[6]	30.18	155.3	164.5	692,209	1,830,632
1980 Avg.[7]	35.53	176.7	192.1	714,379	2,279,615
1981 Avg.	41.89	206.5	218.3	728,506	2,820,505
1982 Avg.[8]	47.25	233.5	248.7	707,552	3,246,071
1983 Avg.		262.2 P	—	—	—
Oct 1982	—	243.9	260.1	701,316	285,328
Nov 1982		245.4	262.5	707,966	287,699
Dec 1982	49.62	246.2	263.0	683,982	288,019
Jan 1983	—	249.0	264.9	688,030	289,075
Feb 1983	—	253.1	267.4	697,089	281,413
Mar 1983	50.35	255.9	269.1	695,976	290,586
Apr 1983	—	257.8	270.9	697,158	286,708
May 1983	—	259.7	274.1	701,712	295,701
Jun 1983	50.51	260.8	273.1	706,933	300,177
Jul 1983		262.5	273.7	704,202	314,566
Aug 1983		265.6	278.9	698,984	311,789
Sep 1983	52.92	267.3	279.4	696,435	312,264
Oct 1983		270.0	281.0		—
Nov 1983		271.4	281.6	—	—
Dec 1983		273.2	—	—	—

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[1] Chamber of Mines of South Africa, Johannesburg: "Analysis of Working Results," published quarterly. The tonnage-weight index of average working costs per metric ton of gold ore milled for 1983 follows. (Base: March quarter 1982 = 100). See page 16 of Report 178 for the description and calculation of index, and page 24 of Report 178 for figures for 1982.

1983:	January-March	111.2
	April-June	111.9
	July-September	117.4

[2] Republic of South Africa Department of Statistics, Pretoria: "Government Gazette: Consumer Price Index for Urban Areas."

[3] For annual averages prior to 1978, April 1970 = 100.

[4] Previously known as the Wholesale Price Index, now the Producer Price Index. The computation remains the same.

[5] Bulletin of Statistics, Department of Statistics, Pretoria.

[6] Historical data for the Average Declared Working Costs and Consumer Price Index 1970-1979 appear on page 4,9 of Report 140.

[7] Monthly data for Codes 35 and 40, 1977-1980, appear on page 28 of Report 157.

[8] Monthly data for 1979-82 appear on page 39 of Report 184.

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GOVERNMENT STATISTICS

UNITED STATES

	Producer Price Index[1]		Consumer Price Index[2]	GNP Implicit Price Deflator[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
	Industrial Commodities (1967=100)	All Commodities (1967=100)	(1967=100)	(1972=100)	Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1972 Avg.	117.9	119.1	125.3	100.00	4.56	4.59	4.26	3.71
1973 Avg.	125.9	134.7	133.1	105.75	4.84	4.98	4.51	3.91
1974 Avg.	153.8	160.1	147.7	115.08	5.44	5.63	4.88	4.21
1975 Avg.	171.5	174.9	161.2	125.79	6.13	6.24	5.39	4.64
1976 Avg.	182.4	183.0	170.5	132.34	6.76	6.87	5.91	4.96
1977 Avg.	195.1	194.2	181.5	140.05	7.28	7.67	6.43	5.39
1978 Avg.[5]	209.4	209.3	195.4	150.42	8.23	8.56	7.02	5.82
1979 Avg.	236.5	235.6	217.4	163.42	9.27	9.50	7.60	6.32
1980 Avg.	274.8	268.8	246.8	178.64	10.26	10.63	8.30	6.94
1981 Avg.	304.1	293.4	272.4	195.51	11.55	11.98	9.12	7.62
1982 Avg.[6]	312.3	299.3	289.1	207.15	12.33	12.94	9.96	8.21
1983 Avg.	315.8P	303.1P	298.4P	215.59P	—	—	10.58P	8.66P
Nov 1982	315.0	300.3	293.6	—	12.53	13.22	10.26	8.45
Dec 1982	315.2	300.7	292.4	210.00	12.53	13.05	10.32	8.51
Jan 1983	313.9	299.9	293.1	—	12.63	13.33	10.34	8.53
Feb 1983	313.9	300.9	293.2	—	12.66	13.29	10.41	8.56
Mar 1983	313.5	300.6	293.4	212.83	12.48	13.35	10.39	8.60
Apr 1983	312.4	300.6	295.5	—	12.67	13.34	10.43	8.60
May 1983	313.6	301.5	297.1	—	12.55	13.62	10.50	8.60
Jun 1983	315.3	302.4	298.1	214.55	12.66	13.38	10.52	8.63
Jul 1983	316.5	303.2	299.3	—	12.68	13.56	10.58	8.69
Aug 1983	317.3R	304.7R	300.3	—	12.63	13.46	10.61	8.64
Sep 1983	317.2	305.3	301.8	216.44	12.71	13.47	10.69	8.75
Oct 1983	318.7	306.3	302.6	—	12.78R	13.56	10.78	8.73
Nov 1983	318.3	305.6	303.1	—	12.78P	13.49P	10.85	8.77
Dec 1983	318.4P	306.0P	303.5P	218.53P	—	—	10.83P	8.85P

P = Preliminary R = Revised since last month

[1] US Bureau of Labor Statistics, Washington, D.C : "Producer Prices and Price Indexes," (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

[2] US Bureau of Labor Statistics, Washington, D.C.: Consumer Price Index for All Urban Consumers, US City Average, All Items.

[3] US Department of Commerce, Washington, D.C.: Bureau of Economic Analysis, National Income and Wealth Division: "Survey of Current Business." The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

[4] US Bureau of Labor Statistics, Washington, D.C.: "Employment and Earnings." 2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for !977-1978 are adjusted to the March 1979 benchmark. Data for January 1979 and beyond are adjusted to the March 1980 benchmark.

[5] Monthly data 1970-1978 for Producer Price Index-Industrial Commodities, Consumer Price Index, and Employment and Earnings SIC codes 10, 333, and 28, and quarterly data for GNP Implicit Price Deflator appear on pages 4.6-4.8 of Report 139.
Monthly data 1977-1978 for Employment and Earnings SIC Codes 10, 333, and 28 appear on page 33 of Report 147.
Monthly data 1970-1978 for Employment and Earnings SIC Code 36 appear on page 23 of Report 154.
Monthly data 1977-1980 for Producer Price Index-All Commodities, appear on page 21 of Nuexco Report 158.

[6] Monthly data 1979-1982 for all listed indices appear on page 41 of Report 184.

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EXECUTIVE SUMMARY
REPORT 187
(All data as of February 29, 1984)

Exchange Value
$17.50, down $3.00

The **Exchange Value** is **$17.50** per pound U_3O_8, down $3.00 since last month. Four uranium sales transactions are reported, involving approximately 2.0 million pounds U_3O_8 equivalent.

Supply-Demand Ratio
declined to 4.5:1

Active spot and near-term **uranium supply** amounts to **5.9 million** pounds U_3O_8 equivalent, up 1.7 million pounds from last month. Active spot and near-term **uranium demand** totals **1.3 million** pounds, up 800 thousand pounds. The spot and near-term **supply-demand ratio** declined to 4.5:1.

Transaction Value
fell $0.55, to $22.50

The **Transaction Value** is **$22.50** per pound U_3O_8, down $0.55 since last month. It includes 13 transactions involving a total of 2.0 million pounds U_3O_8 and equivalent UF_6 and covers a period of 7 months.

Loan Use Charge Rate
unchanged at 6%

The **Loan Use Charge Rate** remains **6 percent** per annum.

Conversion Value
dropped to $0.30

The **Conversion Value** is **$0.30** per pound U as UF_6, down $0.30 since last month. One secondary market conversion transaction is reported. Active secondary market supply of conversion services for delivery within three years totals 3.1 million pounds U as UF_6; active demand amounts to 150 thousand pounds.

SWU Values
$100 for DOE-origin (FY84)
$83 for non-DOE origin
(delivery within 15 months)

The **SWU Values** are **$100** per SWU of DOE origin, down $5 since last month, and **$83** per SWU of non-DOE origin, down $2 since last month. Eight SWU transactions, involving a total of approximately 500 thousand SWUs, are reported this month. Active secondary market SWU supply amounts to approximately 900 thousand SWUs, while active demand totals approximately 300 thousand SWUs.

ANNUAL REVIEW: 1983

Secondary Market
Enrichment Services

This Report presents a review of pricing trends and important developments in the secondary SWU market during 1983.

Australia

The Labor Party's federal election victory marked the onset of a disappointing year for most uranium miners, as development of all uranium projects but one was deferred indefinitely.

Europe

While nuclear power's share of electricity generating capacity continued to grow, prospects for long-term sustained growth in most countries remained in doubt.

US Uranium Balance

Net imports of U_3O_8 to the USA amounted to 6.3 million pounds during 1983, while the net reduction of inventories was approximately 3.0 million pounds.

Focus: France

Recent cuts in the highly successful nuclear power program have led French companies involved with nuclear power to seek foreign markets aggressively.

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NUEXCO REPORT 187 FIGURES OF THE MONTH (February 29, 1984)	This Month (Report 187)	Last Month (Report 186)	12 Months Ago (Report 175)
Exchange Value[1]	17.50	20.50	21.75
Transaction Value[1]	22.50	23.05	20.00
Conversion Value[2]	0.30	0.60	1.40
Loan Use Charge Rate[3]	6%	6%	6%
Near-Term Uranium Supply[4]	5.9	4.2	8.6
Near-Term Uranium Demand[5]	1.3	0.5	2.8
Near-Term Supply-Demand Ratio	4.5	8.3	3.1
Recent Uranium Sales:			
Number of Transactions[6]	4	5	5
Quantity of material[7]	1.5-3.0	5.1-10.0	1.1
Nuexco SWU Values:[8]			
DOE origin, FY 84 delivery	100	105	
non-DOE origin, delivery within 15 months	83	85	
USDOE SWU Prices:			
USEC	135.00	135.00	
AFC	138.65	138.65	138.65
Requirements	149.85	149.85	149.85
Market Value of Enriched UF_6[9, 10]:			
2.5 w/o U_{235}	531.70	586.10	600.94
3.0 w/o U_{235}	684.77	752.87	770.28
3.5 w/o U_{235}	840.99	922.95	942.70
4.0 w/o U_{235}	999.36	1,095.28	1,117.40

---

[1] US $ per pound U_3O_8 equivalent.

[2] US $ per pound U as UF_6.

[3] Per annum.

[4] Active inquiries to sell, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[5] Active inquiries to purchase, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[6] Uranium sales only; does not include loans, conversion, or SWU transactions.

[7] Millions of pounds U_3O_8, equivalent.

[8] US $ per SWU.

[9] Calculated using the Nuexco Exchange Value, Conversion Value, and 0.20 percent tails assay. Calculations before 2/28/83 used the USDOE price for AFC SWUs. From 2/28/83 through 9/30/83, calculations used the Nuexco SWU Value for the relevant fiscal year. As of 10/31/83, calculations use the SWU value for DOE origin and FY 84 delivery.

[10] US $ per KgU as UF_6.

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MARCH 1984 NUMBER 187

Monthly Report on the Nuclear Fuel Market

NUEXCO

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NUEXCO

MONTHLY REPORT ON THE NUCLEAR FUEL MARKET
March 1984 No. 187

R. WESLEY MILLER, *EDITOR* JAMES J. LIGHTNER, *ASSOCIATE EDITOR*

PRICING

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To Our Readers

Please note that the address of Nuexco's office in Atlanta, Georgia has been changed from Suite 500, Seven Piedmont Center to Suite 905, Ten Piedmont Center. Phone, telex and telecopy numbers are unchanged. The complete address now is:

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Atlanta, Georgia 30305.

* * *

Nuexco will host a hospitality suite during the Atomic Industrial Forum's Fuel Cycle Conference in Atlanta, April 1–4. The suite will be located in the Peachtree Plaza Hotel. We look forward to seeing you there.

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NATURAL URANIUM AND CONVERSION

The **Exchange Value** as of February 29, 1984 is **$17.50** per pound U_3O_8, down $3.00 since last month. The *Current Market Data* section of this Report lists four uranium sales transactions, involving a total of approximately 2.0 million pounds U_3O_8 *equivalent.* Two of those transactions were near-term sales of concentrates for prices well below the previous month's Exchange Value; one was a near-term sale completed in December, and one involved long-term deliveries of natural UF_6.

Active supply of uranium (U_3O_8 and UF_6) for spot and near-term delivery totals **5.9 million** pounds U_3O_8 or equivalent UF_6. The corresponding figure for **active demand** is **1.3 million** pounds. The spot and near-term **supply-demand ratio** fell to **4.5:1,** as buyer interest increased with the fall in offering prices.

The **Transaction Value** as of February 29, 1984 is **$22.50** per pound U_3O_8, down $0.55 since last month. The current Transaction Value includes 13 transactions involving a total of 2.0 million pounds U_3O_8 or equivalent UF_6 and covers a period of 7 months.

The **Loan Use Charge Rate** as of February 29, 1984 is **6 percent** per annum, unchanged since last month. No uranium loans are reported.

* * *

The uranium market price structure came under severe pressure during February as several active sellers, suspecting a sustained price decline, scrambled to complete sales. Both producers and inventory holders made offers well below the January 31 Exchange Value. Since very few buyers have unfilled requirements for which they need to purchase in the near term, virtually all spot and near-term uranium demand is discretionary. Therefore, transactions have been concluded only when potential buyers have considered sellers' offers extremely attractive. The sharp decline in offering prices did elicit greater buyer interest, as active near-term uranium demand more than doubled from the level of the previous month.

The current price decline does have momentum. A large amount of inventory has entered the market recently and more is expected in the near future. Prices could move much lower in the coming weeks if sellers continue to compete aggressively for the limited sales opportunities.

The current erosion of spot and near-term prices actually began in the third quarter of 1983, but there was then a hope among sellers that the decline would be contained at around the $20 level. Recent setbacks to nuclear power in the USA have dramatically influenced the market and perceptions about it.

1. In mid-January the US Nuclear Regulatory Commission (NRC) refused Commonwealth Edison a license to operate its Byron Unit 1. The unit had been essentially completed, at a cost of some $3.7 billion. The NRC action was as disturbing as it was unanticipated, especially because Commonwealth Edison has long been regarded as one of the world's most effective constructors and operators of nuclear power plants.

2. Only three days later, Public Service Company of Indiana announced the cancellation of its Marble Hill plant. The two-unit, 2,260-MWe plant had been approximately half completed, at a cost of approximately $2.5 billion. Two other nuclear units had been cancelled within a month before the Marble Hill cancellation, Carolina Power and Light's Harris Unit 2 and Gulf States Utilities' River Bend Unit 1.

3. Soon after the cancellation of Marble Hill, Cincinnati Gas and Electric announced plans to convert its nearly completed Zimmer nuclear unit to a coal-fired plant.

4. The already difficult financial conditions of several nuclear utilities recently have worsened. Those financial pressures have forced some to consider the cancellation of nuclear units under construction. For example, pressure from a public utility commission led Philadelphia Electric late in January to halt construction for 18 months on Limerick Unit 1. Long Island Lighting Company has faced a string of expensive obstacles to completion of its Shoreham unit.

5. On January 18 DOE announced its new Utility Services enrichment contract (USEC), which removed from the market millions of pounds of artificial demand that had been created by enrichment contracts based on over-optimistic forecasts of actual reactor needs. Thus, the USEC enabled utilities substantially to reduce their estimates of long-term uranium demand (unfilled requirements).

All of these events have eliminated, reduced or delayed uranium demand. The prospect of additional inventory selling combined with a further reduction and delay in demand is a prescription for extreme market disruption.

* * *

The **Conversion Value** as of February 29, 1984 is **$0.30** per pound U as UF_6, down $0.30 since last month. This Report lists one conversion transaction, involving 101-300 thousand pounds U as UF_6 sold for a price equivalent to the current Conversion Value. Active secondary market supply of conversion services for delivery within three years totals 3.1 million pounds U as UF_6, more than

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twenty times the corresponding demand figure.

Activity in the secondary conversion market increased during February over the scant level in January. Some sellers of natural UF_6 offered to swap for U_3O_8 at prices equivalent to minimal compensation for the conversion component of the UF_6. The few buyers with small needs for conversion services showed fresh interest in the low prices available. Two other secondary market conversion transactions were in negotiation as this Report went to press, and could be concluded in March.

SECONDARY MARKET ENRICHMENT SERVICES

The secondary market **SWU Values** as of February 29, 1984 are **$100** for **DOE origin** and FY84 delivery, down $5 since last month, and **$83** for **non-DOE origin** and delivery within 15 months, down $2 since last month. The *Current Market Data* section of this Report lists eight SWU transactions involving a total of approximately 500 thousand SWUs, approximately 80 percent of which are for FY84 deliveries. Active secondary market supply of enrichment services totals approximately 900 thousand SWUs, and active demand amounts to approximately 300 thousand SWUs.

* * *

The DOE origin SWU Value declined $5 this month as sellers of FY84 SWUs lowered their offering prices in competition for the few remaining buyers of FY84 SWUs. Activity in the secondary market for DOE origin SWUs, while greater in February than in January, has not yet reached the level anticipated once many utilities formally decide to convert to the USEC, which enables former holders of Requirements contracts to purchase up to 30 percent of their requirements in the secondary market for DOE origin SWUs.

The current demand for FY84 SWUs is limited to the few Requirements contract holders that have decided to convert to the USEC, and to any holders of modified ISCs (Interim Sales Contracts) that have not yet completed purchases for FY84. The market for FY84 SWUs will expire in March due to DOE's 180-day notice period for SWU deliveries; DOE FY85 begins on October 1, 1984.

Utility demand for non-DOE origin SWUs has changed over the past two months, as the 3.5-year Requirements contract holders that had furnished almost all of the demand for non-DOE SWUs either have completed their purchases or have withdrawn from the market to examine the terms of the USEC. As sellers of DOE origin SWUs reduced their offering prices in February, offering prices for SWUs of non-DOE origin also fell to remain competitive.

SECONDARY MARKET ENRICHMENT SERVICES: 1983 REVIEW

Introduction

During 1982 the secondary SWU market had become an integral part of many utilities' overall fuel procurement strategies, and by early 1983 the market was truly international. Nevertheless, during 1983 the secondary SWU market experienced several periods of uncertainty associated with attempts by the US Department of Energy (DOE) to establish policies that would secure its majority share of the international uranium enrichment business. Each such attempt by DOE was followed by rapid adjustments in the market. The last such DOE announcement, made at the beginning of 1984, was a new enrichment contract that effectively institutionalizes the secondary market, but attempts to confine activity in it to SWUs of DOE origin for the next few years.

Secondary Market Development

The factors that have driven the secondary market for enrichment services are the same as those that have driven the U_3O_8 and conversion markets. Overly optimistic demand projections, reactor cancellations and deferrals, inflexible contracts made too far in advance of need, inventory accumulations, and high carrying costs all have combined to produce in many market participants a strong desire to sell excessive inventories and unwanted obligations. The primary potential sellers have been of two classes:

1. Holders of Adjustable Fixed-commitment (AFC) enrichment contracts having excessive or unwanted commitments to DOE;
2. Holders of large inventories, or commitments to take future deliveries, of unwanted non-DOE origin SWUs.

During 1983 many secondary market sellers were willing to accept substantial real losses in return for the benefits of cash inflow and relief from commitments. Sellers'

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offering prices declined to a level at which it was profitable for holders of Requirements contracts having 3.5-year termination provisions to use SWUs purchased in the secondary market to replace existing near-term commitments. Other secondary market SWU buyers included 3.5-year Requirements contract holders that had accepted DOE's offer of the modified ISC, plus various contract holders needing small spot and near-term deliveries to supplement existing commitments.

Pricing Trends

Table 1 shows the Nuexco SWU Values for each month of 1983 beginning with February 28, when the SWU Value was introduced. During the first quarter of the year much of the existing demand was for FY83 SWUs, and the most competitive prices were offered by non-DOE sellers. The most competitive DOE origin offers were discounts of approximately $25 off the AFC price of $138.65, while non-DOE sellers offered the equivalent of as much as $35 below the AFC price. Sellers' offers for FY84 SWUs of all origins were in the range of $110 throughout the first quarter.

Table 1

1983 SWU VALUES

Determined as of the Last Day of Month	Report Number	SWU Values (FY83)	(FY84)
Jan	174	—	—
Feb[1]	175	$103	$110
Mar	176	$106	$110
Apr	177	$103	$109
May	178	—	$103
Jun	179	—	$103
Jul	180	—	$95
Aug	181	—	$95
Sep	182	—	$90
		DOE origin (FY84 delivery)	**Non-DOE origin (delivery within 15 months)**
Oct[2]	183	$115	$85
Nov	184	$110	$90
Dec	185	$105	$85

[1] Nuexco introduced the SWU Value on February 28, 1983.

[2] On October 31, 1983 Nuexco began publishing one SWU Value for DOE origin SWUs and one for non-DOE origin SWUs, to reflect the two-tiered price structure of the secondary SWU market.

The demand for FY83 SWUs had been exhausted by the second quarter of 1983. During the second quarter, competition among sellers to complete FY84 sales led sellers of non-DOE origin SWUs to undercut prices offered by DOE origin sellers. Because of many utilities' preference for SWUs of DOE origin, a price incentive in the range of $5–10 became necessary to induce many potential buyers to purchase SWUs of non-DOE origin. The break-even price for 3.5-year Requirements contract holders considering termination for secondary market participation was approximately $112. Some sellers of DOE origin SWUs were offering at prices as low as $109, so non-DOE origin sellers dropped their offering prices for FY84 SWUs to approximately $103 during May and June.

DOE's concern about the secondary SWU market had been mounting since early 1982, when sellers of non-DOE origin SWUs had begun to penetrate the US market successfully. In August 1982 DOE issued the draft form of the proposed Facility Requirements (FR) contract. Utilities, however, overwhelmingly rejected the FR contract draft. Throughout the first half of 1983 they awaited the issuance of the final FR contract. The expectation of the final contract led most potential sellers of DOE origin SWUs for delivery after FY84 to withdraw from the market until the terms of the new contract could be examined. However, DOE never issued a final version of the FR contract. Instead, in mid-1983 DOE announced that another contract, the Utility Services enrichment contract (USEC), would take the place of the FR contract and would be issued within the coming months.

ISC Offer

DOE also announced, on July 25, 1983, the terms of a new contract available exclusively to holders of 3.5-year Requirements contracts, a class of customers that furnished almost all of the demand for non-DOE origin SWUs in the secondary market. That new contract, the Interim Sales Contract (ISC), offered 3.5-year Requirements contract holders a SWU price equal to that which AFC contract holders paid ($11.20 less than the current Requirements price), in exchange for an agreement not to terminate any contracted SWU deliveries for FY84–85.

The effect of the ISC was to cut the break-even price for potential secondary market participants by $11.20 (to approximately $101), forcing secondary market sellers also to cut their offering prices by that amount if they desired

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to remain competitive. In late July and August DOE origin sellers' offering prices fell to the range of $100, and non-DOE sellers' offers fell to approximately $95. Offering prices declined even further, to approximately $90 for non-DOE origin SWUs, during September.

The ISC failed to interest the 3.5-year Requirements contract holders, and because of secondary market sellers' persistent competitiveness DOE continued to lose business. On October 18 DOE announced modifications to the ISC intended to make it a more attractive offering. The two principle modifications were the following provisions:

1. The customer could obtain in the secondary market *without termination charges* up to 40 percent of requirements for FY84 and 60 percent for FY85, provided that both buyer and seller certify in writing that the secondary market SWUs were of *DOE origin*.
2. The customer, upon choosing to accept the modified ISC, would agree to convert to the USEC when it was issued, provided that its terms were "no less favorable than those in the customer's existing Requirements-type contract when considered in its entirety."

Two-tiered Price Structure

The immediate effect of the modified ISC was to raise the value of DOE origin SWUs in the secondary market and to decrease the value of non-DOE origin SWUs, thereby creating a two-tiered secondary market price structure. The SWU Values as of October 31 were $115 for DOE origin and $85 for non-DOE origin. Because any signers of the modified ISC would be able to accept only SWUs of DOE origin, DOE origin sellers were able to increase their offering prices by approximately $20. Non-DOE origin sellers lowered their offering prices by $5–10 in order to induce potential signers not to accept the contract offer. Customers choosing not to sign the modified ISC would purchase non-DOE origin SWUs because of the high cost of DOE origin SWUs.

In the weeks immediately following modification of the ISC, few potential signers showed much interest in the contract. As a result, DOE origin sellers lowered their offering prices to approximately $110 in November. The main reasons for the lack of interest were:

1. uncertainty about the contract's provision requiring conversion to the USEC upon its issuance;
2. the willingness of non-DOE sellers to make offers that were extremely attractive despite the existence of the modified ISC.

In November DOE clarified the terms of the contract to establish that the *customer* would decide if the USEC were no less favorable than the customer's existing Requirements contract. Following that clarification, interest in the modified ISC increased, and a small number of utilities signed the contract during November and December. The DOE origin SWU Value decreased to $105 in December, however, because of competition among sellers for the limited demand created by the few signers of the modified ISC.

USEC Issuance

DOE withdrew the modified ISC offer on December 30, 1983 when it issued the draft of the USEC. DOE issued the final USEC on January 18, 1984. During January most participants withdrew from the secondary SWU market in order to examine the terms of the USEC. The two-tiered price structure persisted, however, because of the presence of buyers seeking exclusively DOE origin SWUs and because of the continued presence of potential buyers of non-DOE origin SWUs. The SWU Values as of December 31 were $105 for DOE origin SWUs and $85 for non-DOE origin SWUs.

The current USEC SWU price ceiling of $135 is well below the Requirements contract ceiling price and $3.65 less than the AFC price. The relatively low SWU price is one inducement to DOE's existing customers to convert to the contract. The USEC also contains three provisions that have strong implications for the near-term secondary SWU market.

1. Former holders of all Requirements contracts may substitute at no charge DOE origin SWUs acquired in the secondary market for up to 30 percent of reactor requirements for FY84-86 deliveries. This provision will help to promote an active secondary market for DOE origin SWUs.
2. Former holders of AFC contracts must take all of their Appendix A obligations for FY84. They may reduce their FY85 obligations by up to 10 percent, and their FY86 obligations by up to 25 percent, provided the reductions do not cause them to take less than 70 percent of reactor requirements. These provisions are likely to sustain the secondary market supply of DOE origin SWUs at least through FY85. The market for FY84 SWUs will end within the month of March, as DOE's 180-day notice period will become limiting. (DOE FY85 begins on October 1, 1984.)
3. USEC customers may purchase non-DOE SWUs in FY87 and beyond to fill the portion of requirements not purchased from DOE. Demand for DOE origin SWUs on the secondary market could decline markedly in that period.

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1983 SWU Transactions

Table 2 lists data regarding secondary market SWU transactions of which Nuexco is aware and possesses sufficiently complete data for purposes of analysis. A total of approximately 6.8 million SWUs were sold in 50 transactions. (There are five other 1983 SWU transactions of which Nuexco is aware, but regarding which Nuexco does not have complete information.) Approximately half of those 50 transactions involved DOE origin SWUs and half involved non-DOE origin SWUs. While 30 percent (15) of the total number of transactions involved FY83 deliveries, the quantity of SWUs involved in those transactions, 1.1 million, was only 16 percent of the total quantity. While 40 percent (20) of the transactions involved FY84 deliveries, the number of FY84 SWUs sold (2.0 million) amounted to only 30 percent of the total. The 36 percent (18) of transactions involving deliveries in FY85 and beyond accounted for 54 percent (3.7 million) of the total quantity of SWUs sold, mainly because of secondary market sales that entailed multiple annual deliveries. Three of the 50 SWU sales involved deliveries of SWUs for more than one fiscal year prior to FY86.

Table 2

1983 SECONDARY MARKET
SWU TRANSACTIONS[1]

Delivery Period	Number of Transactions	Millions of of SWUs
FY83	15	1.1
FY84	20	2.0
FY85 and beyond	18	3.7
All[2]	50[3]	6.8

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[1] Does not include transactions for which Nuexco has incomplete data. Nuexco began publishing recent SWU transactions in Report 179 of July 1983.

[2] Approximately 50 percent of all transactions involved non-DOE origin SWUs, while the other 50 percent involved SWUs of DOE origin.

[3] Note that three transactions involved deliveries in more than one of the three delivery period categories.

AMPLIFICATION OF DOE SWU CONTRACT PRICE CEILING ESCALATION TERMS

The article entitled "USEC and Requirements Contracts: Comparison of Price Ceiling Escalation Terms," in the *Pricing* section of last month's Report (Number 186), compares the price ceiling terms of the USEC to those of Requirements contracts. While the article was correct as written, it may have given a misleading impression of the relative effect of future energy cost escalation on the ceiling price of each contract.

The most recent Requirements contract ceiling price of $151.93 consists of $123.46 (81 percent) for the escalated power costs, $18.47 (12 percent) for escalated labor costs, and $10.00 for the unescalated portion. Thus, if the cost of power alone were to increase by 10 percent, the Requirements ceiling price would rise by 8.1 percent. By comparison, the current ceiling price under the Utility Services Enrichment Contract (USEC) consists of $67.50 (50 percent) for power rates (demand and energy rates) and $67.50 (50 percent) for general inflation (as measured by the GNPIPD); a 10-percent increase in power costs alone would cause the USEC ceiling price to rise by approximately 5 percent.

Some readers have observed that there is some potential for the Requirements contract ceiling price to be reduced relative to the USEC ceiling. As noted in the referenced article, DOE has stated that it intends to reduce or eliminate the demand charge for power not taken, which could in turn reduce the Requirements contract ceiling price from approximately $165 to as little as $135 in 1984. The likely form of this reduction for power not taken would be a reduction in the contracted power levels. This change would not reduce the USEC ceiling price, which is based on the demand charge *rate*, rather than on the demand charge itself.

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CURRENT MARKET DATA

EXCHANGE VALUE $17.50/lb. U_3O_8
Determined as of February 29, 1984

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE[1]
Determined as of February 29, 1984

$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
22.50	2.0	13	7

Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in:

A. Transactions closed within the previous three-month period for which delivery was scheduled within one year of the transaction date;
B. At least ten transactions;
C. Transactions involving a sum total of at least two million pounds U_3O_8 equivalent.

The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars as of the transaction date.

Comments

Nuexco does not consider the following in determining the Transaction Value:

A. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.
B. The price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of Exchange Value or any other independent variable.
C. Transactions in which the delivery price is defined in such a way that it cannot currently be determined.

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[1] Transaction Values for 1976 through 1981 and their associated parameters (millions of pounds, number of transactions and number of months) are tabulated on pages 31 and 32 of Report 161. The corresponding data for 1982 are tabulated on page 5 of Report 173, and for 1983 on page 5 of Report 186.

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LOAN USE CHARGE RATE[1] 6%
Determined as of February 29, 1984

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrows and lenders have expressed as a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

[1] Monthly data for 1968 through 1981 appear on pages 32-34 of Report 162. Monthly data for 1982 appear on page 2 of Report 173.

CONVERSION VALUE \$0.30/lb. U as UF_6
Determined as of February 29, 1984

Definition

The Conversion Value is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.

Derivation

Nuexco bases the Conversion Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Conversion Value:

A. The price of conversion services delivered or to be delivered under old contracts.
B. The price of conversion services delivered in connection with contract renegotiations or other than arm's length transactions.
C. Transportation charges other than those customarily provided by primary suppliers of conversion services.

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CURRENT MARKET DATA

SWU VALUES

$100/SWU FOR DOE ORIGIN AND FY84 DELIVERY
$83/SWU FOR NON-DOE ORIGIN AND DELIVERY WITHIN 15 MONTHS
Determined as of February 29, 1984

Definition

The SWU (Separative Work Unit) Values represent Nuexco's judgment of the price, expressed in US dollars per SWU, at which transactions for the sale of significant quantities of SWUs of stated origin for delivery in the specified time period could be concluded as of the date indicated.

Derivation

Nuexco bases the SWU Values upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.
E. SWU prices at varying tails assays and varying product assays are converted to the equivalent SWU price at the DOE Reference Transaction Tails Assay (presently 0.20 weight percent U_{235}) and a product assay of 3.0 weight percent U_{235} assuming feed costs calculated using the Nuexco Exchange Value and Nuexco Conversion Value determined as of the last day of the same month.

Comments

Nuexco does not consider the following in determining the SWU Values:

A. The price of SWUs delivered under long-term contracts from primary suppliers, such as DOE, Urenco, or Eurodif.
B. The price of SWUs delivered under other than arm's length transactions.

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EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates This Month (Feb. 29, 1984)	Last Month (Jan. 31, 1984)	12 Months Ago (Feb. 28, 1983)	per kg. U in Concentrates This Month (Feb. 29, 1984)	Last Month (Jan. 31, 1984)	12 Months Ago (Feb. 28, 1983)
Australia (dollar)	18.54	22.33	22.63	48.20	58.06	58.83
Belgium (comm. franc)	933	1,177	1,031	2,426	3,061	2,680
Canada (dollar)	21.89	25.60	26.70	56.91	66.54	69.42
Finland (markka)	98.65	121.81	116.94	256.46	316.67	304.01
France (franc)	140.00	176.42	148.87	363.97	458.65	387.03
FRG (mark)	45.50	57.65	52.41	118.29	149.87	136.25
Italy (lira)	28,262	35,121	30,208	73,476	91,306	78,535
Japan (yen)	4,084	4,809	5,106	10,618	12,502	13,274
Netherlands (guilder)	51.33	64.83	57.97	133.46	168.55	150.71
South Africa (rand)	21.02	25.98	23.45	54.65	67.55	60.95
Spain (peseta)	2,611	3,250	2,825	6,788	8,450	7,344
Sweden (krona)	135.98	167.76	161.23	353.50	436.13	419.16
Switzerland (franc)	37.82	45.97	44.09	98.33	119.52	114.63
UK (pound)	11.71	14.56	14.23	30.44	37.87	36.98
US (dollar)	17.50	20.50	21.75	45.50	53.30	56.55

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates This Month (Feb. 29, 1984)	Last Month (Jan. 31, 1984)	12 Months Ago (Feb. 28, 1983)	per kg. U in Concentrates This Month (Feb. 29, 1984)	Last Month (Jan. 31, 1984)	12 Months Ago (Feb. 28, 1983)
Australia (dollar)	23.84	25.11	20.81	61.97	65.28	54.10
Belgium (comm. franc)	1,200	1,324	948	3,120	3,442	2,464
Canada (dollar)	28.15	28.78	24.55	73.17	74.82	63.84
Finland (markka)	126.83	136.96	107.53	329.73	356.06	279.55
France (franc)	180.00	198.36	136.89	467.96	515.70	355.89
FRG (mark)	58.50	64.82	48.19	152.09	168.52	125.29
Italy (lira)	36,337	39,489	27,778	94,469	102,664	72,216
Japan (yen)	5,251	5,407	4,695	13,651	14,057	12,206
Netherlands (guilder)	66.00	72.90	53.30	171.59	189.52	138.58
South Africa (rand)	27.03	29.21	21.56	70.26	75.95	56.05
Spain (peseta)	3,357	3,655	2,597	8,728	9,501	6,753
Sweden (krona)	174.83	188.63	148.26	454.51	490.38	385.44
Switzerland (franc)	48.63	51.69	40.54	126.42	134.39	105.40
UK (pound)	15.06	16.38	13.08	39.14	42.58	34.01
US (dollar)	22.50	23.05	20.00	58.50	59.92	52.00

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[1] Calculated using currency exchange rates published in the *Wall Street Journal* on February 29, 1984.

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CURRENT MARKET DATA

CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U as UF_6 This Month (Feb. 29, 1984)	per lb. U as UF_6 Last Month (Jan. 31, 1984)	per lb. U as UF_6 12 Months Ago (Feb. 28, 1983)	per kg. U as UF_6 This Month (Feb. 29, 1984)	per kg. U as UF_6 Last Month (Jan. 31, 1984)	per kg. U as UF_6 12 Months Ago (Feb. 28, 1983)
Australia (dollar)	0.32	0.65	1.46	0.70	1.44	3.21
Belgium (comm. franc)	16.00	34.46	66.35	35.27	75.98	146.28
Canada (dollar)	0.38	0.75	1.72	0.83	1.65	3.79
Finland (markka)	1.69	3.57	7.53	3.73	7.86	16.59
France (franc)	2.40	5.16	9.58	5.29	11.38	21.13
FRG (mark)	0.78	1.69	3.37	1.72	3.72	7.44
Italy (lira)	484.50	1,028	1,944	1,068	2,266	4,287
Japan (yen)	70.01	140.75	328.64	154.35	310.29	724.52
Netherlands (guilder)	0.88	1.90	3.73	1.94	4.18	8.23
South Africa (rand)	0.36	0.76	1.51	0.79	1.68	3.33
Spain (peseta)	44.76	95.13	181.82	98.69	209.73	400.84
Sweden (krona)	2.33	4.91	10.38	5.14	10.82	22.88
Switzerland (franc)	0.65	1.35	2.84	1.43	2.97	6.26
UK (pound)	0.20	0.43	0.92	0.44	0.94	2.02
US (dollar)	0.30	0.60	1.40	0.66	1.32	3.09

SWU VALUES EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU FY84	Non-DOE SWU delivery w/in 15 mo.
Australia (dollar)	105.94	87.93
Belgium (comm. franc)	5,333	4,427
Canada (dollar)	125.09	103.83
Finland (markka)	563.70	467.87
France (franc)	800.00	664.00
FRG (mark)	260.01	215.81
Italy (lira)	61,499	134,044
Japan (yen)	23,337	19,370
Netherlands (guilder)	293.34	243.47
South Africa (rand)	120.12	99.70
Spain (peseta)	14,921	12,384
Sweden (krona)	777.00	644.91
Switzerland (franc)	216.12	179.38
UK (pound)	66.91	55.54
US (dollar)	100.00	83.00

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[1] Calculated using currency exchange rates published in the *Wall Street Journal* on February 29, 1984.

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RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
2712	1984	101-300	116	European Producer	US Producer	Took place December 1983.
2710	1984	101-300	105	US Producer	US Producer	
2708	1984	101-300	indeterminate	US Utility	US Utility	Price related to market.
2637	1987-92	1,001-1,500	indeterminate	Canadian Producer	US Utility	UF_6. Price related to market, subject to floor and ceiling.

Secondary Market Conversion Services

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U equivalent)	Approximate Price as Percent of Current C.V.	Seller	Buyer
2686	1984	101-300	100	US Producer	US Utility

Secondary Market Enrichment Services

Nuexco Transaction Number	Delivery Period[2]	Approximate Quantity (thousands of SWUs)	Approximate Price[3] as Percent of Current SWU Value[4]	Tails Assay (Percent U_{235})	Seller Group	Buyer Group	SWU Origin	Remarks
2711	1984	less than 50	less than 106	unknown	US Utility	US Utility	DOE	
2709	1984	less than 50	106	0.3	US Utility	US Utility	DOE	
2698	1989	50-100	indeterminate	to be determined	European Entity	European Utility	Eurodif	Price subject to escalation indices.
2697	1984	101-300	less than 102	0.3	European Producer	US Utility	Eurodif	
2681	1984	less than 50	108	0.3	US Utility	US Utility	DOE	
2674	1984	less than 50	111	0.2	European Entity	US Utility	Eurodif	
2673	1984	less than 50	less than 133	0.25	European Entity	European Utility	DOE	
2635	1984-85	less than 50	indeterminate	0.2	US Utility	European Utility	DOE	AFC less discount.

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[1] Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.

[2] Refers to calendar year, not fiscal year.

[3] Price is not normalized to 0.20% tails assay.

[4] Refers to SWU Value for same origin as SWUs included in transaction.

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CURRENT MARKET DATA

URANIUM SUPPLY
(As of 2/29/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
1575	—	500 per year	1985 on
1818	—	500 per year	1985 on
2038	1,000	—	UF_6
2134	—	250 per year	1984-87
2201	300	—	
2236	—	200 per year	1985-89
2246	100	—	
2263	—	500 per year	1985-90
2274	—	600 per year	1985-91
2275 A	110	—	
2297	—	200 per year	1985-89
2307	340	—	UF_6
2315	170	950	UF_6
2326	—	3,500	1988-91
2335	275	—	
2336	—	250 per year	1985 on
2365	20	—	
2366	400	—	
2368	—	2,500	
2376	100	—	
2389	300	—	
2390	100	—	
2392	35	—	UF_6
2403	1,100	—	UF_6
2421	100	—	
2429	450	—	
2436	850	—	enriched UF_6
2484	130	—	
TOTAL:	5,880		
INACTIVE			
0564	—	1,000 per year	1986-90
2017	1,100	1,200	
2191	125	—	UF_6
2193	—	800 per year	1986-90
2271	—	500 per year	1984-85
TOTAL:	1,225		

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[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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URANIUM DEMAND
(As of 2/29/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2217	—	1,000 per year	1988 on
2302	—	330 per year	1988 on
2329	—	500	1985
2352	240	—	
2411	300	—	
2413	—	250 per year	1986 on
2445	—	250 per year	1988-93
2451	100	—	
2455	25	—	UF_6
2456	650	—	UF_6
TOTAL:	1,315		
INACTIVE			
1999	—	50 per year	1985-90
2118 A	250	—	
2244	—	750 per year	1987 on
2310 A	800	—	enriched UF_6
2372	—	150 per year	1985 on
2414	—	150 per year	1987 on, U_3O_8 or UF_6
2419	50	—	U_3O_8 or UF_6
TOTAL:	1,100		

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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CURRENT MARKET DATA

LOAN SUPPLY AND DEMAND
(As of 2/29/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Within 1 Year	Beyond 1 Year	Remarks
Available for Loan:			
ACTIVE			
1938	1,500	—	UF_6
2128	1,000	—	
2483	545	—	
TOTAL:	3,045		
INACTIVE			
2139	2,000	—	
TOTAL:	2,000		
Inquiries to Borrow:			
INACTIVE			
2118	250	—	U_3O_8 or UF_6
TOTAL:	250		

[1] Measured from the date of this Report.

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CONVERSION SUPPLY AND DEMAND
(As of 2/29/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF_6)		Remarks
	Within 3 Years	Beyond 3 Years	
Available for Sale: ACTIVE			
2051	1,500	—	
2141	1,500	—	
2438	125	—	1985-87
2464	10	—	
TOTAL:	3,135		
INACTIVE			
1936	1,500	—	
2230	300	—	
2401	600	—	
TOTAL:	2,400		
Inquiries to Purchase: ACTIVE			
2397	65	—	
2455 A	85	—	
TOTAL:	150		
INACTIVE			
2287	—	250 per year	1986 on
2295	200	—	
2372 A	—	250 per year	1985 on
2420	300	—	1986
TOTAL:	500		

[1] Measured from the date of this Report.

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SWU SUPPLY
(As of 2/29/84)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
1895	—	500	
2040	55	—	
2052	245	350	
2100	—	100 per year	1984-89
2164	70	—	
2189	—	80	1985
2192	—	325	
2210	—	70	1985
2285	500	3,000	
2345	—	300	1985
2351	—	150 per year	1985-91
2378	—	120 per year	1985-88
2408	—	120	1985
2428	—	200	1985
2436 A	185	—	enriched UF_6
TOTAL:	870		
INACTIVE			
2337	250	250	
2359	180	—	
2375	200	—	
TOTAL:	630		

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[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

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SWU DEMAND
(As of 2/29/84)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2142	—	50	1985-86
2346	—	100 per year	1985-90
2355	—	180 per year	1986,88,90,92
2382	—	80	1985-86
2400	55	85	1985
2404	40	—	
2405	70	—	
2407	—	200	1985-86
2412	—	80	1985
2422	—	2,000	1985-94
2430	120	—	
2447	—	30	1985
2448	30	50	1985-86
TOTAL:	315		
INACTIVE			
2237	—	250 per year	1987 on
2310	200	—	
2449	—	50	1986
2450	—	100	1987
TOTAL:	200		

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[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

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AUSTRALIA

Government Policy

The decisive federal election victory of the Australian Labor Party (ALP) in March 1983 marked the onset of a disappointing year for companies hoping to develop untapped Australian uranium properties. Although the ALP platform called for the cessation of uranium mining and the repudiation of existing contracts, party moderates pushed for a less drastic policy once in power. After several months of confusion and debate among factions of the ALP, the new government announced a uranium policy in November that forbids development of any planned uranium projects except for Olympic Dam in South Australia.

While the policy was bad news for most uranium miners in Australia, elements of pragmatism in it suggest that the government did not bind itself to a radical left-wing ideology.

1. The Prime Minister and his cabinet represent a center position in the ALP, and they made a concerted effort to formulate a policy that addresses the concerns of the public, the needs of the domestic economy, and the nation's reputation as a reliable trading partner.

2. With regard to the concerns of the public, the government established an inquiry by the Australian Science and Technology Council (ASTEC) entitled "Examination of the Issues Related to Australia's Role in the Nuclear Fuel Cycle." The inquiry is designed to provide an assessment of Australia's existing safeguards arrangements and other sensitive issues relating to the nuclear fuel cycle. The ASTEC report is scheduled to be concluded just before the ALP National Conference in July 1984. The results of the inquiry are likely to provide the basis for rational debate at the party conference over the existing uranium policy.

3. The approval of uranium mining at Olympic Dam in South Australia evidenced the government's recognition of the needs of the domestic economy. Copper and uranium exports from Olympic Dam could increase South Australia's export revenues by more than 50 percent, providing an important stimulus to that economically depressed region of the country. Public support for the Olympic Dam project within South Australia is strong, though fragmentary opposition from anti-uranium activists persists. In the view of Party leaders no other potential uranium projects have quite the significance to the national economy that Olympic Dam has. Moreover, after making a survey of the market for Australian uranium, the government decided that international demand was not sufficient to guarantee extensive sales by Australian producers within the decade.

4. The policy demonstrates a commitment to preserve Australia's reputation as a reliable trading partner by allowing the country's operating uranium mills, Ranger and Nabarlek, to continue production and export. Both operations have contracts committing approximately 90 percent of output for several years. Just before announcing the uranium policy, the government approved long-term export contracts between Energy Resources of Australia (ERA), the operator of Ranger, and two US utilities, Wisconsin Electric Power Company and Virginia Electric Power Company. The government agreed in principle to further sales by ERA and Queensland Mines Ltd., the operator of Nabarlek, though no new contracts will be approved until after the completion of the ASTEC inquiry. Present negotiating licenses are restricted to the US market.

The government's uranium policy is marked by some encouraging elements, considering the extremism of the most vocal factions of the ALP. It seems possible that the prospects for the future development of uranium properties may improve, particularly if the results of the ASTEC inquiry are favorable, thereby acting to defuse some of the emotionalism within the Party's ranks.

Production Results

Mary Kathleen Uranium Ltd. (MKU), ERA and Queensland Mines all experienced a substantial growth in profits during 1983. Total U_3O_8 production from Australia in 1983 amounted to approximately 8.4 million pounds U_3O_8, a decline of 3.2 million pounds from the 1982 level of 11.6 million pounds. The decline can be attributed to two factors.

1. The Mary Kathleen mine in Queensland ceased production in October 1982. It had contributed approximately 2.0 million pounds of the 1982 total. MKU made shipments from stock during 1983.

2. The Ranger mine stopped producing U_3O_8 at the beginning of December when unions struck over low wages and rent hikes in ERA-owned housing. While causing annual production to fall off, the strike had no effect on deliveries. It ended in mid-January of this year.

Kakadu Park

Among the most promising of Australia's undeveloped uranium properties are two in the Alligator River uranium province in the Northern Territory, Jabiluka and

Koongarra. (See Report 181 of September 1983 for an overview of Australia's potential as a uranium producing nation.) Koongarra, which Denison Mines acquired in 1980, sits within Phase One of Kakadu National Park, a unique tropical wetland preserve. The previously ruling Liberal Party exempted the Koongarra project area from the strict no-mining conditions applying elsewhere in the Park. In the third quarter of 1983 Denison arrived at a settlement with Aboriginal landowners in the region, clearing a remaining obstacle to project development.

In February 1984 the Labor government implemented Phase Two of Kakadu Park, expanding it to include the region in which Jabiluka is located. The Jabiluka project area has been excluded from the park, thereby safeguarding the rights of the developers under the mining lease granted by the previous government. The park includes the land surface to a depth of 1,000 meters.

Strong support for Jabiluka and Koongarra exists within the Northern Territory. Provincial elections held early in December, just after announcement of the government's uranium policy, returned only 5 ALP candidates out of 25 seats in the Territory's Legisative Assembly. Pancontinental Mining Ltd., which owns 65 percent of Jabiluka, had already entered into commercial agreements selling some of its share of Jabiluka's future output when the government policy was announced. (Getty Oil of the USA, recently acquired by Texaco, owns the remaining 35 percent of Jabiluka, and Texaco has declared its intention to liquidate all non-oil holdings.)

New Uranium Extraction Technique

The Australian Atomic Energy Commission (AAEC) developed a new uranium extraction technique in 1983 that is now used at the Nabarlek mill. The extraction process uses a permonosulphide acid known as Caro's acid in place of pyrolusite as the oxidizing agent to dissolve the 25 percent or so of uranium remaining in the ore after acid treatment. The AAEC reportedly worked on the process with Interox Chemicals Ltd., a European conglomerate with extensive interests in Australia. The Caro's acid process costs less and has associated environmental advantages. Unlike pyrolusite, which yields manganese in the oxidation process, Caro's acid yields only water after leaching.

EUROPE

Introduction

During 1983 nuclear power's share of electricity generating capacity grew steadily in Europe. The public and governmental debate over nuclear power remained very much alive, however, calling into question the long-term strength of national programs committed to the use of nuclear energy for diversification of electricity sources. European nations continued to develop greater autonomy in all aspects of the nuclear fuel cycle.

Belgium

The 900 MWe PWR Tihange Unit 2 began commercial operation during 1983, increasing Belgium's total nuclear generating capacity to 3,450 MWe from five operational units. Construction on two other units is well under way. While consumption of coal and oil in Belgium dropped during 1983, that of nuclear-generated electricity increased by 38 percent. The Belgian government currently is divided over the country's participation in the twin 1300 MWe Chooz PWRs in France.

Early in 1983 Belgium renewed its commitment to domestic reprocessing capability when the government approved reactivation of the Eurochemic reprocessing plant at Mol. The plant should operate at a capacity of 60 tonnes per year by 1990, although the desired capacity is 300 tonnes per year, a level that would cover all domestic needs and foreign business as well. Belgium cooperates closely with France on several aspects of the nuclear fuel cycle, and is a participant in the Super-Phenix fast breeder reactor program. Through its fuel cycle services company Synatom, Belgium owns 11.11 percent of Eurodif.

France

In France, the nation with the largest and fastest growing nuclear power program in Europe, five 900 MWe PWRs began commercial operation during 1983. By year-end, a total of 35 units were operating commercially, while 27 more were under construction or planned. However, Electricite de France (EDF), the state utility, encountered financial difficulties and the nuclear program became subject to heightened criticism as installed capacity outdistanced electricity demand growth. The French national utility managed its power surplus in 1983 by exporting a record amount of electricity and by scaling back capacity factors of operating units by approximately 5 percent. Meanwhile, associated nuclear industries stepped

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up their activities in international markets during the year. French domestic uranium production from six operating mills totalled approximately 8.5 million pounds U_3O_8. (For more information regarding the nuclear industries in France, see the *Focus* article in this Report.)

Federal Republic of Germany

The Federal Republic of Germany (FRG) proceeded steadily with the convoy program during 1983, while operating units performed well. Two of the country's twelve operational nuclear power units, Grafenrheinfeld and Biblis Unit A, were the only reactors rated at more than 1,000 MWe to appear on *Nuclear Engineering International*'s list of the world's 20 best-performing units. One unit, Kreummel, entered commercial operation in 1983. Activity by intervenors in the FRG, great in recent years, was less marked in 1983, possibly because many intervenors were busy protesting NATO's defense policies. Early in 1984 Isar Unit 2 suffered an irritating setback when a court order forced a halt to construction because of a minor design change. The results of an appeal by the unit's owners are still pending. By reviving controversy about the nuclear industry, the Isar Unit 2 episode could have the effect of rekindling legal obstructionism. (For more information on the FRG's nuclear program, see the *Focus* article in Report 184 of December 1983.)

Switzerland

Switzerland's four operating commercial nuclear units had excellent performance records during 1983, achieving an average load factor of 87.6 percent. The country's fifth unit, Leibstadt, which is located at the confluence of the Rhine and Aare rivers near the border with the FRG, is due to begin commercial operation this year. After several Swiss and German groups alleged that the new unit would be detrimental to the local environment, a joint Swiss-German commission determined that the only significant environmental effect of the Leibstadt plant will be shadows created by the cooling towers.

Switzerland's sixth nuclear reactor is the planned Kaiseraugst unit, around which a heated political debate continues. The future of nuclear power in Switzerland may be decided by the so-called "green" initiative on the subject scheduled to be voted on later this year. Passage of the initiative would bring about a gradual end to the nation's nuclear program. Most of the public opposition to nuclear power is concentrated on the issue of waste disposal. The government is seeking waste burial sites within the country and has faced strong opposition in virtually every canton. A new perspective on the issue has emerged recently as the government of the People's Republic of China has raised the possibility of commercial waste disposal within its borders (a profitable prospect for the PRC).

Italy

The Italian government reaffirmed its intention to reduce reliance on imported oil, in part by increasing nuclear power's share of electricity generating capacity from the current 3 percent to 20 percent in 1995. Laws passed early in 1983 enable the government to preempt local opposition to nuclear plants and offer financial and industrial incentives to localities that choose to accept plant sites. For the state's nuclear power plan to reach fruition, construction will need to begin soon on approximately 9,000 MWe of nuclear capacity.

Italy's nuclear power plan of a decade ago never materialized. One of the effects of its delay was the creation of huge fuel inventories held by the state entities responsible for nuclear fuel procurement. During 1983 those entities were major participants in the nuclear fuel market as they attempted to relieve the burden of unneeded supplies.

Spain

Nuclear generating capacity increased by 19 percent during 1983 as Asco Unit 1 and Almaraz Unit 2 commenced full power operation in August, and Almaraz Unit 1 resumed full power operation after repair of long-standing steam generator problems. There are currently six units in commercial operation and seven under construction. Electricity consumption grew by 3.3 percent during 1983, one of the highest growth rates in Europe. Nevertheless, the Socialist government announced in October a national energy plan that includes drastic cuts in the nation's nuclear generating plan. The plan is scheduled to go to parliament this month (March 1984). If it passes, indefinite deferral of five of the seven reactors under construction can be expected.

The government's plan has aroused criticism from economic planners convinced that demand growth in Spain will continue. The nuclear utilities (and their creditors) responsible for the projects likely to be shelved also have filed vehement protests. Among the reactors likely to be cut from the country's program are the two Lemoniz units located in the Basque country. While the local government claims that the units, one of which is near completion, are essential to reduce the region's almost 100-percent dependence on electricity imports, Basque nationalist opposition is fierce. The government shelved the Lemoniz project temporarily in 1982 after terrorists murdered the plant's project manager.

Another controversial plant likely to suffer from the current government policy in Spain is Valdecaballeros. Plant technicians at the site of Valdecaballeros Unit 1 made public allegations late in 1983 that "incredible defects" had been built into the plant. While the operating utility, Hidroelectrica Española, has contested the charges, the allegations may have done irreparable political damage. (For more information about uranium demand and supply in Spain, see the *Focus* article in Report 180 of August 1983.)

Portugal

The Portuguese government issued in 1983 a long-awaited master energy plan that advocates reducing the nation's 83-percent reliance on imported oil. The plan calls for a study of potential reactor sites, reactor types and waste disposal sites, to be completed by mid-1984. Portugal's one operating uranium mine, Urgeirica, produced approximately 300 thousand pounds U_3O_8 in 1983. The country is considering developing other uranium deposits.

United Kingdom

Construction proceeded smoothly in the UK during 1983 on nine advanced gas-cooled reactors (AGRs) due to enter commercial operation by 1991. At year-end four of those units had reached or were near completion; they are scheduled to add 2,500 MWe to nuclear generating capacity in 1984. The dominant public event during the year regarding nuclear power was the Sizewell inquiry, which fell far behind its original schedule. A decision on the Sizewell Unit B-1 PWR does not appear likely until mid-1985 at the earliest. The debate over Sizewell focused on economics during 1983, but the emphasis may shift to reactor type in the coming months as evidence in favor of alternatives to the PWR is presented.

The discovery on nearby beaches of highly radioactive material discharged late in 1983 from British Nuclear Fuels Ltd.'s (BNFL) Sellafield reprocessing plant in northwest England has tainted the public debate over nuclear power in recent weeks. The government has been investigating the incident on both environmental and legal grounds, and has reprimanded BNFL for alleged negligence. Several changes in BNFL's management have ensued. (For information about the UK nuclear power program, see the *Focus* article in Report 185 of January 1984.)

Netherlands

Currently two reactors, having a total generating capacity of approximately 500 MWe, are in commercial operation in the Netherlands. At the end of 1983 a study group appointed by the state to gauge public opinion on alternate energy sources reported it had discovered little public support for nuclear power. While the study's use of non-random sampling and other examples of unscientific methodology rendered its results inconclusive, much political weight has been attached to it. Therefore, the chances for further development of nuclear power appear slim. According to the study, the popular energy scheme in the Netherlands is a combination of reduced growth, solar and wind power, and greater conservation, along with a slowdown in the use of fossil fuels, increased care in the use of natural gas, and extinction of plans for nuclear power.

The Dutch utility PZEM (Provinciale Zeeuwse Energie Maatschappij), operator of the 445-MWe Borssele unit, signed a long-term SWU contract with Urenco late in 1983. The Dutch company Ultra-Centrifuge Nederland (UCN) owns 33.3 percent of Urenco (BNFL of the United Kingdom and Uranit of the FRG also own one-third shares of the centrifuge enrichment company), and one of Urenco's two plants is located at Almelo in the Netherlands (the other is in Capenhurst, UK).

Sweden

The ten operating nuclear units in Sweden, which provide approximately 40 percent of the electricity consumed in the country each day, performed smoothly during 1983. One new reactor, the Swedish State Power Board's (SSPB) Ringhals Unit 4, began commercial operation in November, and the last two units in the nation's twelve-unit nuclear program neared completion. A 1980 national referendum called for the phasing out of all nuclear plants in Sweden by the year 2010. Laws also require the nuclear utilities, SSPB, OKG (Oskarshamnsverkets Kraftgrupp) and Sydkraft, to demonstrate safe handling of spent fuel in order to operate plants commercially.

A spent-fuel storage facility under construction at OKG's Oskarshamn plant site will serve all Swedish reactors when it enters service in 1985. SSPB, OKG and Sydkraft all terminated long-term SWU contracts with DOE in 1983 and purchased replacement SWUs from the Italian state utility ENEL (Ente Nationale per L'Energie Electrica). SSPB and Sydkraft began receiving deliveries totalling approximately 1 million pounds annually from

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Saskatchewan Mining Development Corporation (SMDC) of Canada in 1983.

On December 27, a nationwide electricity blackout occurred in Sweden when a fire at a small regional transformer station triggered automatic shutdowns in 7 out of 8 nuclear reactors that were operating at the time. Most of the country was without electricity for several hours, and all of the nation's emergency generating sources had to be turned on.

Finland

During 1983 nuclear units continued to perform well in Finland, where TVO (Teollisuuden Voima Osakeyhtio) operates two 660-MWe units, and IVO (Imatran Voima Oy) operates two Soviet-made 440-MWe units. Those units provide close to half of the nation's electricity requirements. TVO announced early in the year that a domestic interim storage facility for spent fuel will be operating in 1988. The utility buys most of its uranium from one Canadian producer and one Australian producer, and has contracts with Techsnabexport of the Soviet Union for enrichment services. The Soviet Union supplies all of IVO's uranium and fuel cycle needs.

1983 US CONSUMPTION VS. US PRODUCTION

Analysis

Nuexco's current estimate of 1983 uranium consumption for use in US commercial nuclear power plants amounts to 30.5 million pounds. Comparing that consumption level to the US Department of Energy (DOE) production estimate of 21.2 million pounds yields a domestic shortfall of 9.3 million pounds. Although Nuexco estimates that imports of uranium into the USA totaled 12.3 million pounds, US exports of 6.0 million pounds U_3O_8 reduced net imports to 6.3 million pounds U_3O_8. The balance of the shortfall was supplied from inventories. The foregoing analysis is summarized in Table 3.

Table 3

1983 US U_3O_8 CONSUMPTION VS. PRODUCTION
(millions of pounds U_3O_8 equivalent)

Consumption[1]	30.5
Production[2]	21.2
Consumption — Production	9.3
Imports[3]	12.3
Exports[3]	6.0
Net Imports	6.3
Net Reduction of Inventories	3.0

[1] Nuexco estimate.
[2] USDOE estimate.
[3] Nuexco estimate.

Derivation of Consumption Estimate

The term U_3O_8 *consumption* refers to uranium that is processed, fabricated and installed for the operation of commercial nuclear power units. Unless Nuexco has specific information indicating otherwise, the analysis assumes that U_3O_8 destined for use in initial cores is consumed, and therefore added to the consumption total, 24 months before a unit's scheduled commerical operation date (COD). The analysis assumes that U_3O_8 for each unit's first reload is consumed 18 months before the scheduled reload date; similarly, the analysis assumes a 12-month lead time for consumption of U_3O_8 associated with all subsequent reloads.

Nuexco's current estimate of US uranium consumption represents an upward revision of 1.6 million pounds as compared to the estimate of 28.9 million pounds published in Report 182 of October 1983. The methodology for arriving at the October figure, explained in detail in that Report, involves several reactor-specific variables, including thermal power, capacity factor and fuel enrichment levels. Tails assays are assumed to be 0.25 weight-percent U_{235}. The 1.6-million-pound increase since October reflects adjustments in the timing of U_3O_8 consumption associated with first cores.

Discussion

Despite the gap between domestic production and consumption, US utilities imported directly from non-US sellers less than one-sixth the amount of total consumption. Of the 12.3 million pounds U_3O_8 imported to the USA in 1983, only 5.1 million pounds went directly to utilities. Most uranium imported was purchased by US *producers* interested in acquiring U_3O_8 or UF_6 at low prices and using it to fulfill existing contract obligations.

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Nuexco projects US uranium production to decline from the 1983 level by approximately 5 million pounds in 1984, while consumption should rise slightly, thereby increasing the gap between domestic production and consumption. As in 1983, the difference should not cause alarm among US utilities. In general, four factors are likely to increase utilities' feelings of security regarding fuel supply during 1984.

1. US utilities are generally well-supplied for the next few years, and given the rate of delays and cancellations to reactor operation schedules, domestic utility inventories will continue to represent several years' worth of forward consumption.

2. The presence of a large active supply of uranium from aggressive sellers outside the USA as well as within the USA is keeping downward pressure on prices. That pressure appears likely to persist for the near future.

3. Uranium production in almost all producer countries that are traditional trading partners of the USA continues to increase or remain steady. The mining of new high-grade deposits is bringing into the market large quantities of uranium that can be sold economically at very low prices. While there will always be a certain preference by US utilities for US-origin material, the internationalization of the uranium market gradually has reduced US utilities' sensitivity to national origin.

4. The US production sector is highly resilient in the sense that numerous US companies have experience in the uranium field and, in the event of domestic need of sufficient urgency, could enter the field with relative quickness.

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FOCUS

FRANCE

Introduction

Nuclear power in France has achieved the prominence denied to it elsewhere in the world. Commercial nuclear power stations' share of electricity generating capacity has grown remarkably, from less than 2 percent in 1977 to approximately 50 percent as of the end of 1983. Other sectors of the nuclear fuel cycle have experienced notable gains as well. The oil price shock of the early 1970s promoted France's nuclear industries, as the state utility, Electricite de France (EDF), set a course for aggressive development of alternate electricity sources. EDF currently generates more nuclear electricity than any other utility in the Western World.

Electricity demand growth rates in France have declined during the past few years, however, and EDF's nuclear power program has been criticized as too ambitious. During 1983 the government reduced the official plan for nuclear generating capacity in 1990 from 66 GWe to 56 GWe. The utility has a rapidly growing surplus of generating capacity. French companies involved in the front end of the fuel cycle have begun to compete more aggressively in international markets as the outlook for the domestic nuclear program has begun to change.

Nuclear Power Plant Construction

Thirty-five nuclear units (counting the 233 MWe Phenix fast breeder reactor) are currently in commercial operation in France, representing total nuclear generating capacity of approximately 26 GWe (Table 4). Twenty-three more units are under construction and four are on order; those units are scheduled to add a total of approximately 31.4 GWe by the early 1990s (Table 5). Figure 1 shows the locations of nuclear generating stations in France.

With the exception of Chooz Unit A, a 310-MWe PWR completed in 1967, all of the units in commercial operation in France through 1972 were gas-cooled reactors (GCRs) based on technology developed in the United Kingdom. The experimental Phenix fast breeder reactor began operation at the end of 1973. Since then the commercial nuclear power program has been dominated by PWR technology purchased from Westinghouse of the USA by the French manufacturer Framatome.

The first phase of the PWR program began in 1970 with a plan for construction of six 900-MWe units by the end of the decade, two at the Fessenheim site in Alsace and four at the existing Bugey site east of Lyon. The 1970 plan was superseded quickly in 1973–74, however, as high oil prices forced French economic planners to reevaluate the country's heavy dependence on imported oil. Based on high forecasts of electricity demand, EDF began to place orders for a line of eighteen 900-MWe PWRs. Fourteen of those units started commercial operation during 1980 and 1981. Ten more units, comprising the second line of 900-MWe PWRs, were ordered or planned in 1976. Because of plant standardization, multiple yearly orders, and an assertive national attitude, reactor construction time averaged 60 months by the early 1980s.

Annual orders for a new line of 1300-MWe PWRs began in 1977 in keeping with continued projections of rapid growth in electricity demand. To date none of the larger PWRs has begun commercial operation, but the Paluel Units 1 and 2 are scheduled for commercial operation in the first half of this year. The government approved a second generation of eight more 1300-MWe PWRs in 1979, and during 1983 two more units were ordered, Penly Unit 1 and Chooz Unit B-1. A total of nineteen 1300-MWe PWRs are now under construction or on order.

The government of France continues to support its aggressive nuclear power plant construction program primarily for three reasons.

1. Greater emphasis on nuclear energy has reduced the need to purchase oil at higher dollar prices, and has enabled France to sell oil stockpiles, thereby easing the balance of payments deficit caused by the currently devalued franc.
2. Nuclear-related industries employ a substantial workforce, and the current economic climate in France has made those jobs especially valuable.
3. Many economic planners contend that the creation of a large electrical power infrastructure is a prerequisite for long-term economic growth.

EDF's Current Overcapacity

Although arguments in favor of nuclear power development are generally accepted within France, EDF's large and growing surplus of power capacity has stimulated a serious reassessment of domestic energy policy. In mid-1983 primary energy consumption had declined by 4.6 percent from the previous year, reaching a level equal to that of 1975. France's established nuclear plant construction program is based on sustained electricity demand *growth* at the rate of 2.5 percent per year.

The utility's problems have been magnified by commitments to coal and natural gas as well as to nuclear power. Actual coal usage fell during 1983 as older coal-fired sta-

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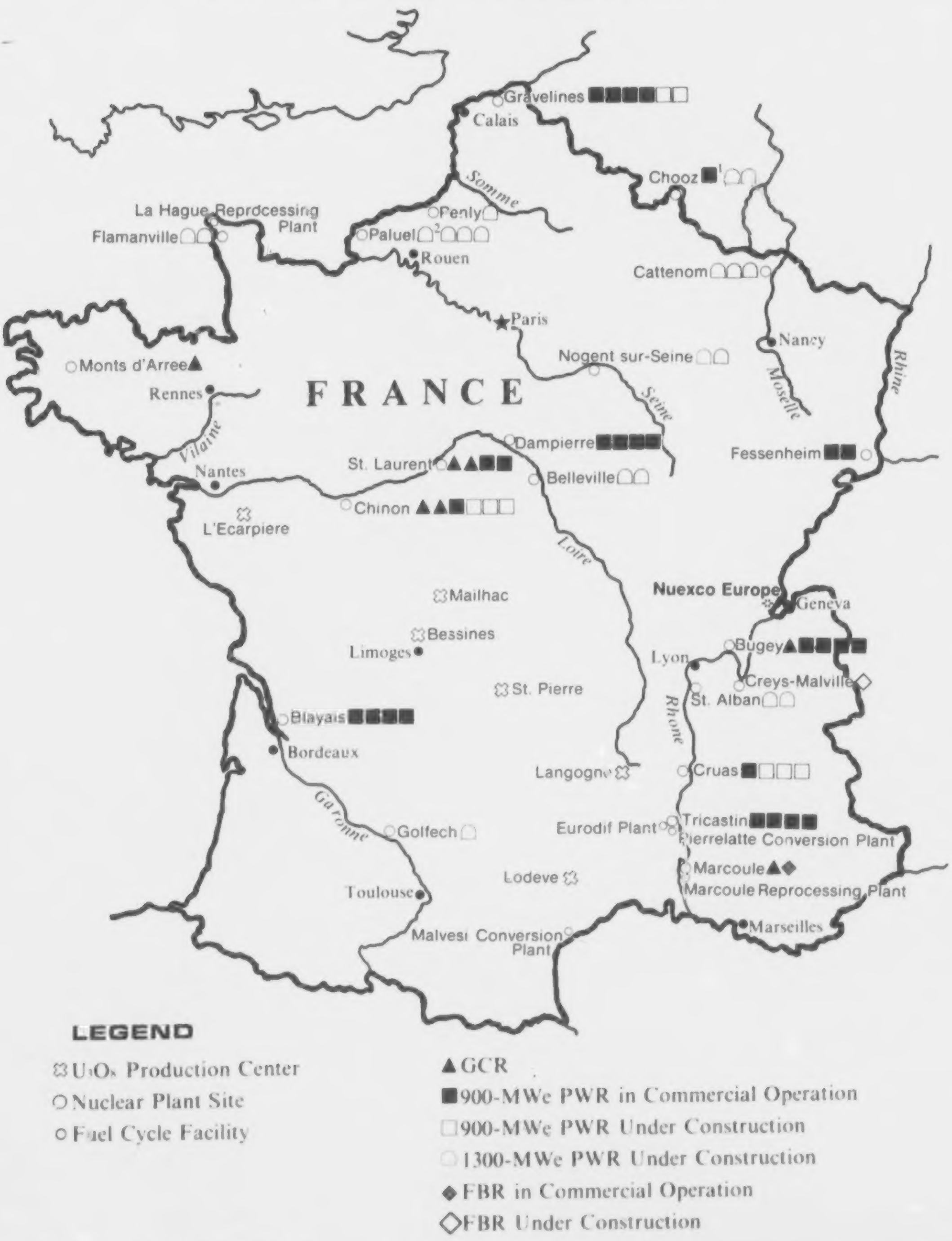
Figure 1

NUCLEAR PLANT SITES AND URANIUM PRODUCTION CENTERS IN FRANCE


Gravelines ■■■■□□
Calais
Chooz ■[1]
Somme
La Hague Reprocessing Plant
Flamanville
Penly
Paluel[2]
Rouen
Cattenom
Paris
Nancy
Nogent sur-Seine
Monts d'Arree ▲
Rennes
FRANCE
Seine
Moselle
Rhine
Vilaine
Dampierre ■■■■
Fessenheim ■■
St. Laurent ▲▲■■
Nantes
Belleville
Chinon ▲▲■□□□
L'Ecarpiere
Loire
Nuexco Europe
Geneva
Mailhac
Bessines
Bugey ▲■■■■
Limoges
Lyon
Creys-Malville ◇
St. Pierre
St. Alban
Rhone
Blayais ■■■■
Bordeaux
Langogne
Cruas ■□□□
Garonne
Golfech
Eurodif Plant
Tricastin ■■■■
Pierrelatte Conversion Plant
Marcoule ▲◆
Lodeve
Marcoule Reprocessing Plant
Toulouse
Marseilles
Malvesi Conversion Plant
LEGEND
U₃O₈ Production Center
Nuclear Plant Site
Fuel Cycle Facility
▲ GCR
■ 900-MWe PWR in Commercial Operation
□ 900-MWe PWR Under Construction
1300-MWe PWR Under Construction
◆ FBR in Commercial Operation
◇ FBR Under Construction

[1] Chooz Unit A is a 300-MWe PWR

[2] Paluel Unit 1 begins commercial operation in March 1984

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Table 4

NUCLEAR POWER UNITS IN FRANCE IN COMMERCIAL OPERATION

Unit	MWe (Net)	Type	COD[1]
Marcoule G-3	40	GCR	May 1960
Chinon 2	210	GCR	Feb 1965
Chooz A	310	PWR	Apr 1967
Monts d'Arree	70	GCHWR[2]	Jul 1967
Chinon 3	400	GCR	Aug 1967
St. Laurent des Eaux 1	460	GCR	Mar 1969
St. Laurent des Eaux 2	515	GCR	Aug 1971
Bugey 1	540	GCR	Apr 1972
Phenix	233	FBR	Dec 1973
Fessenheim 1	880	PWR	Dec 1977
Fessenheim 2	880	PWR	Mar 1978
Bugey 2	920	PWR	Feb 1979
Bugey 3	920	PWR	Feb 1979
Bugey 4	900	PWR	Jun 1979
Bugey 5	900	PWR	Jan 1980
Dampierre 1	890	PWR	Sep 1980
Gravelines B-1	910	PWR	Nov 1980
Gravelines B-2	910	PWR	Dec 1980
Tricastin 1	915	PWR	Dec 1980
Tricastin 2	915	PWR	Dec 1980
Dampierre 2	890	PWR	Feb 1981
Dampierre 3	890	PWR	May 1981
Tricastin 3	915	PWR	May 1981
Gravelines B-3	910	PWR	Jun 1981
Gravelines B-4	910	PWR	Oct 1981
Dampierre 4	890	PWR	Nov 1981
Tricastin 4	915	PWR	Nov 1981
Blayais 1	910	PWR	Dec 1981
Blayais 2	910	PWR	Feb 1983
St. Laurent des Eaux B-2	880	PWR	Jun 1983
Cruas 1	880	PWR	Aug 1983
Blayais 4	910	PWR	Sep 1983
St. Laurent des Eaux B-1	880	PWR	Oct 1983
Chinon B-1	870	PWR	Oct 1983
Blayais 3	910	PWR	Nov 1983
TOTAL MWe	26,188		

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[1] Commercial operation date. Information from *Nuclear News* World List of Nuclear Power Plants and utility publications.

[2] GCHWR = Gas-cooled, heavy-water moderated reactor.

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Table 5

NUCLEAR POWER UNITS IN FRANCE UNDER CONSTRUCTION AND ON ORDER

Unit	MWe (Net)	Type	Percent Complete	COD[1]
Paluel 1	1290	PWR	100	Mar 1984
Cruas 3	880	PWR	99	Apr 1984
Gravelines C-5	910	PWR	98	Jul 1984
Paluel 2	1290	PWR	98	Jul 1984
Cruas 4	880	PWR	98	Aug 1984
Cruas 2	880	PWR	95	Nov 1984
Chinon B-2	870	PWR	95	Nov 1984
Paluel 3	1290	PWR	80	May 1985
St. Alban 1	1300	PWR	80	Jun 1985
Flamanville 1	1290	PWR	75	Sep 1985
Gravelines C-6	910	PWR	70	Nov 1985
Paluel 4	1290	PWR	55	Mar 1986
St. Alban 2	1300	PWR	55	May 1986
Cattenom 1	1265	PWR	55	Jun 1986
Flamanville 2	1290	PWR	50	Aug 1986
Chinon B-3	870	PWR	35	Feb 1987
Cattenom 2	1265	PWR	40	May 1987
Belleville 1	1275	PWR	35	Sep 1987
Chinon B-4	870	PWR	25	Nov 1987
Nogent sur-Seine 1	1275	PWR	25	Apr 1988
Belleville 2	1275	PWR	20	Aug 1988
Nogent sur-Seine 2	1275	PWR	15	Jan 1989
Cattenom 3	1265	PWR	5	Apr 1989
Penly 1	1290	PWR	0	Oct 1989
Golfech 1	1275	PWR	0	Jan 1990
Chooz B-1	1270	PWR	0	indefinite
Chooz B-2	1270	PWR	0	indefinite
TOTAL MWe	31,410			

[1] Commercial operation date. Information from *Nuclear News* World List of Nuclear Power Plants and utility publications.

tions were removed from the grid, but new coal-fired plants are being built to replace the old ones. The French government is reluctant to make big cuts to the coal-generating program because of high unemployment in the nation's coal-mining regions. Agreements to purchase natural gas from the Netherlands, Norway, the USSR and Algeria add to the energy surplus.

EDF has taken a number of steps to ease its overcapacity problems.

1. It has reduced new nuclear plant orders to approximately two per year (with one export sale every two years), a level that the government considers to be the minimum rate necessary to maintain a viable French reactor industry.

2. It has extended the average construction time per nuclear unit from 60 months to 78 months to slow the pace of new units reaching completion.

3. It has cut back an average of 5 percent on operating plants' capacity factors.

4. It has marketed electricity to neighboring countries aggressively, exporting a record amount in 1983.

5. It has attempted to capture a larger share of industrial power demand within France.

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Uranium Industry Structure

Four large organizations dominate French uranium interests: the state Commissariat a l'Energie Atomique (CEA); Compagnie Francaise des Petroles (CFP), of which the state owns 35 percent; the state-owned metals company Pechiney; and Imetal, France's largest producer of non-ferrous metals. CEA owns half of Framatome and 100 percent of Cogema (Compagnie General des Matieres Nucleaires), which is the most active company in the nuclear fuel cycle in France. CFP owns Total Compagnie Miniere (Total), which controls Compagnie Miniere Dong-Trieu (CMDT) and all of the interests that formerly belonged to Minatome. Pechiney owns shares in Amok in Canada, Comuf in Gabon and Somair in Nigeria, and interests in several other companies related to the fuel cycle. Imetal owns Compagnie Francaise Mokta, which has both domestic and offshore uranium interests. (Cogema owns 12.14 percent of Imetal and presumably influences the activities of Mokta.) Figure 2 diagrams some of the ownership relations of these organizations.

CEA enlarged its share of Framatome to one-half recently after making a 20-percent acquisition using commercial profits. (EDF had competed to buy the share.) The other 50 percent of Framatome is controlled by Creusot Loire. Framatome has become one of the leading reactor manufacturers in the world. The advantages to CEA of ownership in Framatome include the ability to combine the manufacturer's interests with those of Cogema. Framatome and Cogema are working together on the sale of reactors to several developing countries, including China, Egypt, South Korea, and Taiwan. The combined effort enables the French to offer attractive packages that include all fuel requirements.

Cogema has extensive interests in uranium properties, owns 39 percent of the French convertor Comurhex and 61.14 percent of Eurodif[1], has ownership interests in fuel fabrication companies, and operates the country's Marcoule and La Hague reprocessing plants. In France, its wholly-owned subsidiary SIMO (Societe Industrielle des Minerais de L'Ouest) operates three of the country's six active uranium mills: L'Ecarpiere, Bessines and Lodeve. Cogema also purchases all of the output from Langogne, which is operated by Mokta. The company owns shares of uranium operations in the former French colonies Niger and Gabon (Figure 2) and purchases a large percentage of the output from those countries.

In Canada Cogema owns 30 percent of Amok (along with Pechiney (45 percent) and Mokta (25 percent)), and takes 100 percent of Amok's 80-percent share of Cluff Lake production. Cogema is also the parent of SERU Nucleaire Limitee (Societe d'Etudes et de Recherches d'Uranium), which has a 33.625 percent stake in the Waterbury Joint Venture, owner of the rich Cigar Lake deposit in northern Saskatchewan. Cogema's US branch, Cogema Inc., acquired 80 percent of Pathfinder Mines from General Electric in 1981. Pathfinder produces uranium at Gas Hills and Shirley Basin in Wyoming.

From these sources and others Cogema accounts for a total of approximately 20 percent of Free World U_3O_8 production annually. The company supplies EDF with almost all of the utility's annual deliveries. Much of the remainder of Cogema's production share supplies contracts with non-French customers negotiated by Cogema and Uranex, Cogema's predecessor as CEA's uranium marketing agency.

Like Cogema, Total Compagnie Miniere has diverse and widespread uranium interests. Total acquired the two major private French uranium producers, Minatome and Dong-Trieu, late in 1982. Among the interests that Total assumed upon acquisition of Minatome were 10 percent ownership of Rossing in Namibia, 94-percent ownership of SCUMRA (Societe Centrale de l'Uranium et des Minerais et Metaux Radioactifs), the operator of St. Pierre in France, and full ownership of the Ben Lomond uranium deposit in Queensland, Australia. Dong-Trieu is the operator of the Mailhac mill in France.

Uranium Pechiney, the branch of Pechiney responsible for nuclear-related businesses, holds a 51-percent share of Comurhex, a 27-percent share of Transnucleaire and shares in the fuel fabricators FBFC (Societe Franco-Belge de Fabrication de Combustible) and CFC (Cogema Framatome Combustible) in addition to its interests in Amok, Comuf and Somair. Mokta operates the domestic production facility at Langogne, and owns 39 percent of Comuf and 19.38 percent of Somair in addition to its 25-percent share in Amok.

Output from domestic mills totalled approximately 8.5 million pounds U_3O_8 in 1983. The six operating uranium mills process ore mined from scattered orebodies of varying sizes located in Brittany, the Vendee, the Massif Central and Languedoc. Average grade ranges from 0.10-0.20 percent U_3O_8. Table 6 lists the six operating mills, their operators and estimated 1983 U_3O_8 production.

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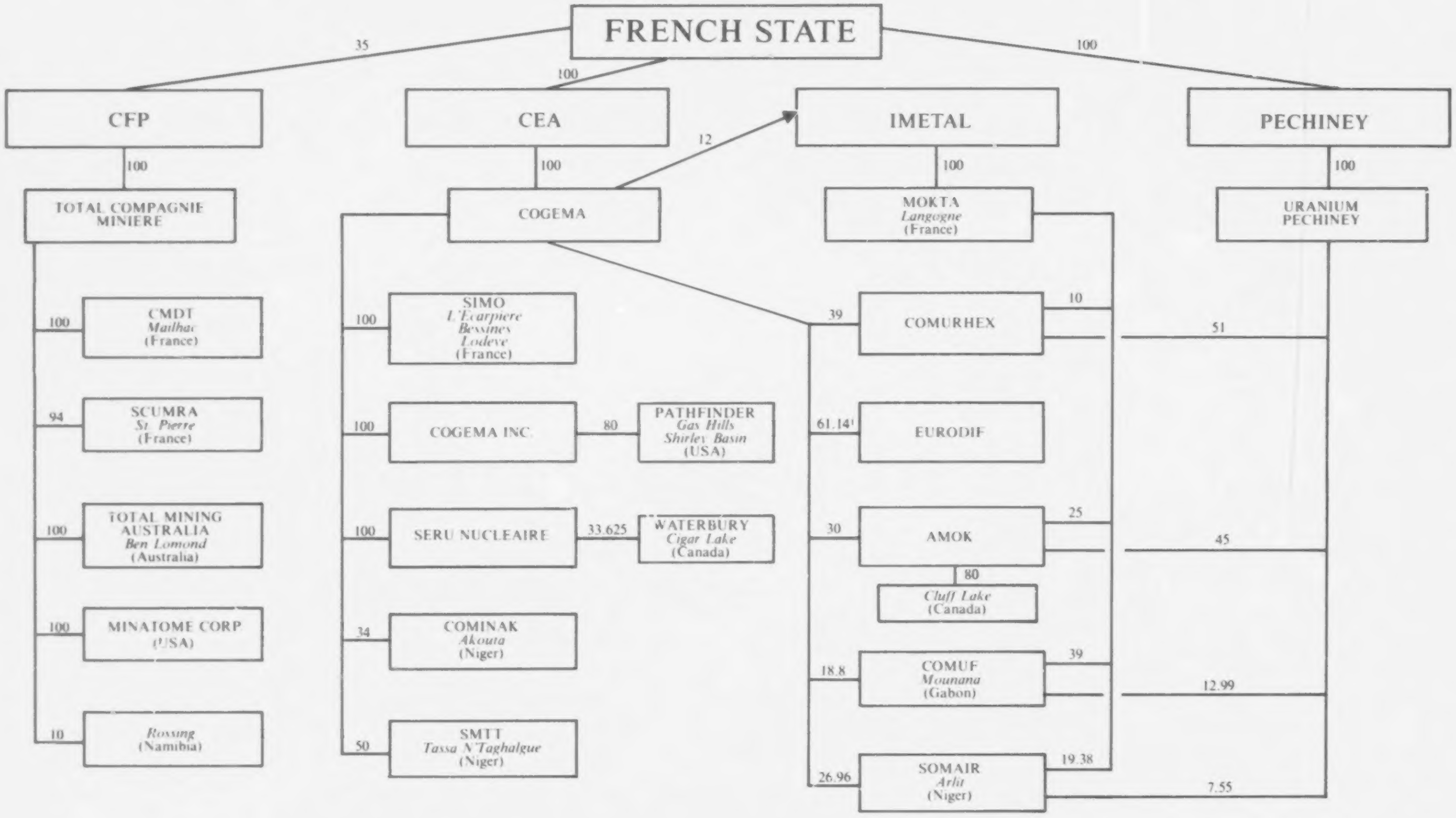
[1] Assumes Cogema controls share originally belonging to Iran Atomic Energy Organization

Figure 2

FRENCH OWNERSHIP INTERESTS IN URANIUM PROJECTS


FRENCH STATE
35
100
100
CFP
CEA
IMETAL
PECHINEY
12
100
100
100
100
TOTAL COMPAGNIE MINIERE
COGEMA
MOKTA Langogne (France)
URANIUM PECHINEY
100
CMDT Mailhac (France)
94
SCUMRA St. Pierre (France)
100
TOTAL MINING AUSTRALIA Ben Lomond (Australia)
100
MINATOME CORP (USA)
10
Rossing (Namibia)
100
SIMO L'Ecarpiere Bessines Lodeve (France)
100
COGEMA INC.
80
PATHFINDER Gas Hills Shirley Basin (USA)
100
SERU NUCLEAIRE
33.625
WATERBURY Cigar Lake (Canada)
34
COMINAK Akouta (Niger)
50
SMTT Tassa N'Taghalgue (Niger)
39
COMURHEX
10
51
61.14¹
EURODIF
30
AMOK
25
45
80
Cluff Lake (Canada)
18.8
COMUF Mounana (Gabon)
39
12.99
26.96
SOMAIR Arlit (Niger)
19.38
7.55

LEGEND

CEA	—Commissariat a l'Energie Atomique	SCUMRA	—Societe Centrale de l'Uranium et des Minerais et Metaux Radioactifs
CFP	—Compagnie Francaise des Petroles		
CMDT	—Compagnie Miniere Dong-Trieu	SERU	—Societe d'Etudes et de Recherches d'Uranium
COGEMA	—Compagnie General des Matieres Nucleaires	SIMO	—Societe Industrielle des Minerais de L'Ouest
COMINAK	—Compagnie Miniere d'Akouta	SMTT	—Societe Miniere de Tassa N'Taghalque
MOKTA	—Compagnie Francaise de Mokta	SOMAIR	—Societe des Mines de L'Air

[1] Assumes Cogema controls share originally belonging to Iran Atomic Energy Organization

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Table 6

OPERATING URANIUM MILLS IN FRANCE

Mill	Operator	Estimated 1983 Output (million pounds U_3O_8)
L'Ecarpiere	SIMO[1]	1.4
Bessines	SIMO	2.7
Lodeve[2]	SIMO	2.7
Langogne	Mokta	0.5
Mailhac	Dong-Trieu	1.0
St. Pierre	SCUMRA[3]	0.2
Total 1983 Production		8.5

[1] SIMO = Societe Industrielle des Minerais de L'Ouest.

[2] See the *Raw Materials* section of Report 182 for a description of the Lodeve project.

[3] SCUMRA = Societe Centrale de l'Uranium et des Minerais et Metaux Radioactifs.

Fuel Cycle Services

Comurhex, of which Pechiney owns 51 percent, Cogema 39 percent and Mokta 10 percent, supplies virtually all of EDF's conversion needs. Plant facilities are located in Southern France at two sites, Malvesi and Pierrelatte. The Malvesi plant converts concentrates to UF_4, which is shipped to Pierrelatte for conversion to UF_6. Total annual capacity is approximately 12,000 MTU.

EDF has two Requirements contracts and one AFC contract with DOE for deliveries through FY86, and has sold most of its excess DOE commitments in the secondary market. Future purchases from DOE are unlikely, as most of the national utility's enrichment needs are supplied by Eurodif. Eurodif operates at Tricastin in Southern France a gaseous diffusion enrichment plant having a production capacity of 11.1 million SWUs per year. Table 7 shows the ownership shares of Eurodif.

Table 7

EURODIF OWNERSHIP

Entity	Country	Percent Share
Cogema	France	61.14[1]
Synatom	Belgium	11.10
Enusa[2]	Spain	11.10
CNEN[3]	Italy	8.33
Agip Uranio	Italy	8.33

[1] Assumes Cogema controls share originally belonging to Iran Atomic Energy Organization.

[2] Enusa = Empresa Nacional del Uranio SA.

[3] CNEN = Comitat Nazionale per L'Energia Nucleare.

Summary

Since the early 1970s, France has moved to the forefront in all industry sectors associated with nuclear power generation. It is the only nation having an ambitious nuclear power program that has adhered relatively closely to its plans of the past decade. The state utility, EDF, generates more electricity from nuclear power plants than any other utility in the industrialized West. Framatome, the country's reactor manufacturer, is one of the most active in the world. A longstanding commitment to advanced technology has given rise to the 1200-MWe Super-Phenix fast breeder reactor now under construction at Creys Malville.

The declining rates of domestic electricity demand growth in recent years have caused an electricity generating capacity surplus, and have led the state to reduce its long-term nuclear generating plan. To redress the slack in demand resulting from reductions to the domestic program, the French supply sectors have taken bold steps to export power, technology, fuel cycle services and material. French companies presently supply approximately 20 percent of the natural uranium market, 30 percent of the conversion market and almost 25 percent of the enrichment market.

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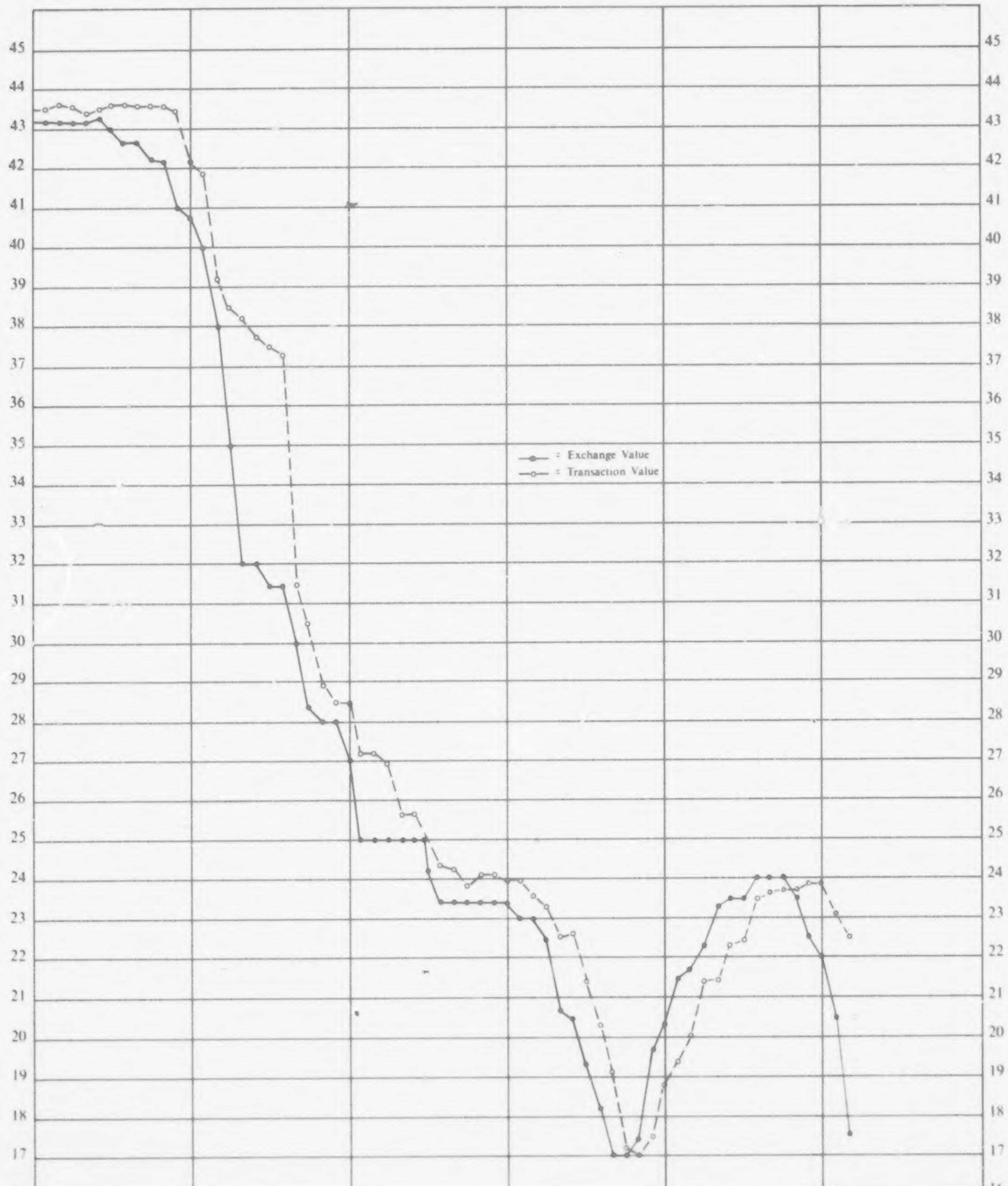
HISTORICAL MARKET DATA

EXCHANGE AND TRANSACTION VALUES SINCE JANUARY 1979

Determined as of the last day of the month indicated



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HISTORICAL MARKET DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	32.50	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00
1984	20.50	**17.50**										

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85
1984	23.05	**22.50**										

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60
1984	0.60	**0.30**										

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AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage Earners, Weekly Rates[2] (1976=100)
1972 Avg.	105.6	71.3
1973 Avg.	124.4	79.0
1974 Avg.	141.9	108.1
1975 Avg.	150.4	132.6
1976 Avg.	168.4	160.9
1977 Avg.	192.0	179.0
1978 Avg.[3] [4]	198.5	190.0
1979 Avg.	248.8	127.9
1980 Avg.	321.8	140.8
1981 Avg.	355.3	154.1
1982 Avg.[5]	368.6	174.9
1983 Avg.	—	181.7
Nov 1982	375.9	178.5
Dec 1982	374.9	179.5
Jan 1983	385.7	179.6
Feb 1983	387.5	179.8
Mar 1983	397.4	179.7
Apr 1983	407.3	180.0
May 1983	414.8	180.1
Jun 1983	415.6	180.2
Jul 1983	408.4	179.9
Aug 1983	403.1	179.8
Sep 1983	403.1	179.7
Oct 1983	397.6P	187.5R
Nov 1983	—	187.4R
Dec 1983	—	187.2P

P = Preliminary R = Revised since last month

[1] Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0).

[2] Australian Bureau of Statistics, Canberra: "Award Rates of Pay Indexes, Australia" (Catalogue No. 6312.0). Figures for the latest fourteen months shown are subject to revision.

[3] Monthly data for 1970-78 appear on pages 4.7 and 4.8 of Report 138.

[4] Annual averages prior to 1979 reflect index base no longer in use.

[5] Monthly data for 1979-82 appear on page 35 of Report 184.

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GOVERNMENT STATISTICS

CANADA

		Wage-earner Data: Average Hourly Earnings (C$)[2]						
	Industry Selling Price Index: Manufacturing[1] (1971=100)	**Uranium Mines (SIC 057)**	**Metal Mines (SIC 051-059)**	**Mines, Quarries and Oil Wells[3] (SIC 051-099)**	**Primary Metal Industries**			**Chemicals and Chemical Products[5] (SIC 370-379)**
					(SIC 296)	**Non-ferrous[4] (SIC 296-298)**	**(SIC 298)**	
1979 Avg.[6]	217.9	—	9.60	9.66	—	7.35	—	7.67
1980 Avg.	247.2	—	10.59	10.80	—	8.05	—	8.50
1981 Avg.	288.7	—	12.02	12.23	—	9.03	—	9.53
1982 Avg.[7]	288.8	—	13.74	13.92	—	9.98	—	10.63
1983 Avg.	298.7	—	14.65	14.29	—	—	—	11.18
Oct 1982	292.1	—	13.83	13.89	—	10.18	—	10.86
Nov 1982	291.3	—	14.42	14.28	—	10.43	—	10.90
Dec 1982	292.3	—	14.54	14.32	—	10.55	—	11.06
Jan 1983	292.7	—	14.36	14.35	—	10.72	—	11.06
Feb 1983	293.5	—	14.24	14.28	—	10.74	—	11.06
Mar 1983[8]	295.2	16.79	14.84	14.48	—	10.93	—	11.21
Apr 1983	297.1	16.83	14.40	14.13	11.57	—	10.10	11.02
May 1983	298.5	17.02	14.50	14.10	11.39	—	9.82	10.97
Jun 1983	299.3	17.02	14.60	14.07	11.33	—	9.84	11.05
Jul 1983	300.4	16.48	14.35	13.93	11.70	—	9.83	11.04
Aug 1983	301.2	16.93	14.36	13.89	11.82	—	10.08	11.19
Sep 1983	301.0	17.66	14.90	14.41	11.99	—	10.32R	11.29
Oct 1983	301.5	17.73	15.27	14.65	11.76	—	10.03	11.30
Nov 1983	301.7R	17.82R	15.29R	14.67R	11.78R	—	10.62R	11.38R
Dec 1983	302.6R	—	14.71P	14.46P	11.79P	—	10.53P	11.55P
Jan 1984	304.5P	—	—	—	—	—	—	—

P = Preliminary R = Revised since last month

[1] Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (Catalogue 62-011). Indexes for the most recent six months shown are subject to revision.

[2] Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours" (Catalogue 72-002).

[3] Reports 175 through 185 list this series title incorrectly as "Metal Mining, Including Milling (SIC 050-099)".

[4] Beginning with the April 1983 figure, Primary Metal Industries, non-ferrous is split into SIC 296 and SIC 298

[5] Chemical and Chemical Products prior to April 1983 was SIC 370-379. The new series is from a new survey which includes all companies and is based on a 1970 classification. The old survey only included companies of 20 employees or more.

[6] Monthly ISPI for 1977 and 1978 appear on page 4.10 of Report 138, and monthly wage-earner data for 1973-78 appear on page 4.11 of Report 138.

[7] Monthly data for 1979-1982 appear on page 37 of Report 184. On that page, the wage earner index entitled "Metal Mining, Including Milling (SIC 050-099)" should read Total Mining (SIC 051-099)".

[8] Beginning with the April 1983 figure, Wage Earner Data are based on a census of all companies employing 200 or more wage earners, *plus* a random survey of companies employing fewer than 200 wage earners. Prior to April 1983 only companies employing fewer than 200 wage earners are included in the Wage Earner Data.

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GOVERNMENT STATISTICS

REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100)	Producer Price Index All Groups[4] (1975=100)[3]	Total Employment in Mining and Quarrying (Code 35)[5]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[5]
1972 Avg.	8.79	113.3	63.9	623,067	443,933
1973 Avg.	10.51	124.1	72.3	684,743	572,133
1974 Avg.	13.18	138.5	85.3	674,140	761,596
1975 Avg.	16.71	157.2	100.0	639,473	1,003,617
1976 Avg.	19.30	174.7	115.1	671,240	1,212,983
1977 Avg.	23.87	194.4	130.0	712,006	1,420,670
1978 Avg.	27.14	137.2	142.7	664,571	1,537,169
1979 Avg.[6]	30.18	155.3	164.5	692,209	1,830,632
1980 Avg.[7]	35.53	176.7	192.1	714,379	2,279,615
1981 Avg.	41.89	206.5	218.3	728,506	2,820,505
1982 Avg.[8]	47.25	233.5	248.7	707,552	3,246,071
1983 Avg.	51.87	262.2	274.8	—	—
Nov 1982	—	245.4	262.5	707,966	287,699
Dec 1982	49.62	246.2	263.0	683,982	288,019
Jan 1983	—	249.0	264.9	688,030	289,075
Feb 1983	—	253.1	267.4	697,089	281,413
Mar 1983	50.35	255.9	269.1	695,976	290,586
Apr 1983	—	257.8	270.9	697,158	286,708
May 1983	—	259.7	274.1	701,712	295,701
Jun 1983	50.51	260.8	273.1	706,933	300,177
Jul 1983	—	262.5	273.7	704,202	314,566
Aug 1983	—	265.6	278.9	698,984	311,789
Sep 1983	52.92	267.3	279.4	696,435	312,264
Oct 1983	—	270.0	281.0	693,225	311,418
Nov 1983	—	271.4	281.6	688,459	317,485
Dec 1983	53.70	273.2	283.7	—	—

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[1] Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly. The tonnage-weight index of average working costs per metric ton of gold ore milled for 1983 follows. (Base: March quarter 1982 = 100). See page 16 of Report 178 for the description and calculation of index, and page 24 of Report 178 for figures for 1982.

1983:	January-March	111.2
	April-June	111.9
	July-September	117.4
	October-December	119.6

[2] Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."

[3] For annual averages prior to 1978, April 1970 = 100.

[4] Previously known as the Wholesale Price Index, now the Producer Price Index. The computation remains the same.

[5] Bulletin of Statistics, Department of Statistics, Pretoria.

[6] Historical data for the Average Declared Working Costs and Consumer Price Index 1970-1979 appear on page 4.9 of Report 140.

[7] Monthly data for Codes 35 and 40, 1977-1980, appear on page 28 of Report 157.

[8] Monthly data for 1979-82 appear on page 39 of Report 184.

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GOVERNMENT STATISTICS

UNITED STATES

	Producer Price Index[1]		Consumer Price Index[2]	GNP Implicit Price Deflator[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
	Industrial Commodities (1967=100)	All Commodities (1967=100)	(1967=100)	(1972=100)	Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1972 Avg.	117.9	119.1	125.3	100.00	4.56	4.59	4.26	3.71
1973 Avg.	125.9	134.7	133.1	105.75	4.84	4.98	4.51	3.91
1974 Avg.	153.8	160.1	147.7	115.08	5.44	5.63	4.88	4.21
1975 Avg.	171.5	174.9	161.2	125.79	6.13	6.24	5.39	4.64
1976 Avg.	182.4	183.0	170.5	132.34	6.76	6.87	5.91	4.96
1977 Avg.	195.1	194.2	181.5	140.05	7.28	7.67	6.43	5.39
1978 Avg.[5]	209.4	209.3	195.4	150.42	8.23	8.56	7.02	5.82
1979 Avg.	236.5	235.6	217.4	163.42	9.27	9.50	7.60	6.32
1980 Avg.	274.8	268.8	246.8	178.64	10.26	10.63	8.30	6.94
1981 Avg.	304.1	293.4	272.4	195.51	11.55	11.98	9.12	7.62
1982 Avg.[6]	312.3	299.3	289.1	207.15	12.33	12.94	9.96	8.21
1983 Avg.	315.8	303.1	298.4	215.62R	12.67	13.44	10.58	8.66
Nov 1982	315.0	300.3	293.6	—	12.53	13.22	10.26	8.45
Dec 1982	315.2	300.7	292.4	210.00	12.53	13.05	10.32	8.51
Jan 1983	313.9	299.9	293.1	—	12.63	13.33	10.34	8.53
Feb 1983	313.9	300.9	293.2	—	12.66	13.29	10.41	8.56
Mar 1983	313.5	300.6	293.4	212.83	12.48	13.35	10.39	8.60
Apr 1983	312.4	300.6	295.5	—	12.67	13.34	10.43	8.60
May 1983	313.6	301.5	297.1	—	12.55	13.62	10.50	8.60
Jun 1983	315.3	302.4	298.1	214.55	12.66	13.38	10.52	8.63
Jul 1983	316.5	303.2	299.3	—	12.68	13.56	10.58	8.69
Aug 1983	317.3	304.7	300.3	—	12.63	13.46	10.61	8.64
Sep 1983	317.1R	305.3	301.8	216.44	12.71	13.47	10.69	8.75
Oct 1983	318.7	306.3	302.6	—	12.78	13.56	10.78	8.73
Nov 1983	318.3	305.6	303.1	—	12.72R	13.56R	10.86R	8.78R
Dec 1983	318.4	306.0	303.5	218.67R	12.85P	13.38P	10.89R	8.85
Jan 1984	319.2	308.1P	305.2P	—	—	—	10.90P	8.88P

P = Preliminary R = Revised since last month

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[1] US Bureau of Labor Statistics, Washington, D.C.: "Producer Prices and Price Indexes," (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

[2] US Bureau of Labor Statistics, Washington, D.C.: Consumer Price Index for All Urban Consumers, US City Average, All Items.

[3] US Department of Commerce, Washington, D.C.: Bureau of Economic Analysis, National Income and Wealth Division: "Survey of Current Business." The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

[4] US Bureau of Labor Statistics, Washington, D.C.: "Employment and Earnings." 2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for 1977-1978 are adjusted to the March 1979 benchmark. Data for January 1979 and beyond are adjusted to the March 1980 benchmark.

[5] Monthly data 1970-1978 for Producer Price Index-Industrial Commodities, Consumer Price Index, and Employment and Earnings SIC codes 10, 333, and 28, and quarterly data for GNP Implicit Price Deflator appear on pages 4.6-4.8 of Report 139.
Monthly data 1977-1978 for Employment and Earnings SIC Codes 10, 333, and 28 appear on page 33 of Report 147.
Monthly data 1970-1978 for Employment and Earnings SIC Code 36 appear on page 23 of Report 154.
Monthly data 1977-1980 for Producer Price Index-All Commodities, appear on page 21 of Nuexco Report 158.

[6] Monthly data 1979-1982 for all listed indices appear on page 41 of Report 184.

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EXECUTIVE SUMMARY
REPORT 188
(All data as of March 31, 1984)

Exchange Value **\$17.00, down \$0.50**	The **Exchange Value** is **\$17.00** per pound U_3O_8, down \$0.50 since last month. Nine uranium sales transactions are reported, involving approximately 2.5 million pounds U_3O_8 equivalent.
Supply-Demand Ratio **declined to 1.6:1**	Active spot and near-term **uranium supply** amounts to **6.1 million** pounds U_3O_8 equivalent, up 200 thousand pounds from last month. Active spot and near-term **uranium demand** totals **3.8 million** pounds, up 2.5 million pounds. The spot and near-term **supply-demand ratio** declined sharply to **1.6:1.**
Transaction Value **fell \$3.25, to \$19.25**	The **Transaction Value** is **\$19.25** per pound U_3O_8, down \$3.25 since last month. It includes 12 transactions involving a total of 3.2 million pounds U_3O_8 and equivalent UF_6 and covers a period of 5 months.
Loan Use Charge Rate **unchanged at 6%**	The **Loan Use Charge Rate** remains **6 percent** per annum.
Conversion Value **climbed to \$0.80**	The **Conversion Value** is **\$0.80** per pound U as UF_6, up \$0.50 since last month. One secondary market conversion transaction is reported. Active secondary market supply of conversion services for delivery within three years totals 3.6 million pounds U as UF_6; active demand amounts to 65 thousand pounds.
SWU Values **\$100 for DOE-origin (FY85)** **\$80 for non-DOE origin** **(delivery within 15 months)**	The **SWU Values** are **\$100** per SWU of DOE origin and FY85 delivery, and **\$80** per SWU of non-DOE origin, down \$3 since last month. Ten SWU transactions, involving 630 thousand SWUs, are reported this month. Active secondary market SWU supply amounts to approximately 1.5 million SWUs, while active demand totals 860 thousand SWUs.
Essay	Particularly in times of increased market activity, it is useful for all market participants to understand the terms *bid, offer* and *inquiry*, as these terms characterize the typical interactions between buyers and sellers.
Australia	A new proposal by the Minister for Energy and Resources indicates the Australian Labor Party may be moving to moderate its anti-uranium stance.
Japan	Several nuclear units have made recent progress toward commercial operation. The utilities continue to evaluate options for their future enrichment requirements.
South Africa	The 1983 production results from Palabora Mining Company have been issued. Three uranium producers have indicated they will scale back production this year because of low prices.
Spain	The government's new official nuclear generating plan calls for five units currently under construction to be deferred indefinitely.
Analysis and Commentary	An analysis of nuclear units on order and under construction in the USA shows that, despite the current mood of pessimism, 18 units are near commercial operation.
Analysis and Commentary	One of the primary explanations for Japan's successful commercial nuclear power program is the high degree of cooperation between the government and the utilities in planning and licensing power plants.
Basic Considerations	Since 1982 Eurodif's enrichment plant in southern France has had the capacity to produce 10.8 million SWUs per year, but the company's production commitments have fallen well short of capacity.
Raw Materials	The Rossing Project in Namibia is the largest open-pit uranium mine in the world. This Report presents the first half of a two-part article on Rossing.

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NUEXCO REPORT 188 FIGURES OF THE MONTH (March 31, 1984)	This Month (Report 188)	Last Month (Report 187)	12 Months Ago (Report 176)
Exchange Value[1]	17.00	17.50	22.25
Transaction Value[1]	19.25	22.50	21.35
Conversion Value[2]	0.80	0.30	1.40
Loan Use Charge Rate[3]	6%	6%	6%
Near-Term Uranium Supply[4]	6.1	5.9	7.5
Near-Term Uranium Demand[5]	3.8	1.3	2.9
Near-Term Supply-Demand Ratio	1.6	4.5	2.6
Recent Uranium Sales:			
Number of Transactions[6]	9	4	7
Quantity of Material[7]	1.5-3.0	1.5-3.0	6.7-7.4
Nuexco SWU Values:[8]			
DOE origin, FY85 delivery	100	—	—
non-DOE origin, delivery within 15 months	80	83	—
USDOE SWU Prices:			
USEC	135.00	135.00	—
AFC	153.00[11]	138.65	138.65
Requirements	157.00[11]	149.85	149.85
Market Value of Enriched UF_6[9] [10]:			
2.5 w/o U_{235}	530.76	531.70	616.48
3.0 w/o U_{235}	683.62	684.77	790.32
3.5 w/o U_{235}	839.63	840.99	967.34
4.0 w/o U_{235}	997.79	999.36	1,146.70

[1] US $ per pound U_3O_8 equivalent.

[2] US $ per pound U as UF_6.

[3] Per annum.

[4] Active inquiries to sell, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[5] Active inquiries to purchase, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[6] Uranium sales only; does not include loans, conversion, or SWU transactions.

[7] Millions of pounds U_3O_8, equivalent.

[8] US $ per SWU.

[9] Calculated using the Nuexco Exchange Value, Conversion Value, and 0.20 percent tails assay. Calculations before 2/28/83 used the USDOE price for AFC SWUs. From 2/28/83 through 9/30/83, calculations used the Nuexco SWU Value for the relevant fiscal year. From 10/31/83 through 2/29/84, calculations used the Nuexco SWU Value for DOE origin and FY84 delivery. As of 3/31/84, calculations use the Nuexco SWU Value for DOE origin and FY85 delivery.

[10] US $ per KgU as UF_6.

[11] Prices published in the Federal Register on April 4, 1984.

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APRIL 1984 NUMBER 188

Monthly Report on the Nuclear Fuel Market

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NUEXCO

MONTHLY REPORT ON THE NUCLEAR FUEL MARKET

April 1984 No. 188

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NATURAL URANIUM AND CONVERSION

The **Exchange Value** as of March 31, 1984 is **$17.00** per pound U_3O_8, down $0.50 since last month. The *Current Market Data* section of this Report lists nine uranium sales transactions, involving a total of approximately 2.5 million pounds U_3O_8 *equivalent.* All nine transactions involved spot or near-term deliveries; three involved deliveries of natural UF_6 and one was a sale of enriched product.

Active supply of uranium (U_3O_8 and UF_6) for spot and near-term delivery totals **6.1 million** pounds U_3O_8 or equivalent UF_6. The corresponding figure for **active demand** is **3.8 million** pounds. The spot and near-term **supply-demand ratio** fell to **1.6:1,** as buyer interest increased with the fall in offering prices.

The **Transaction Value** as of March 31, 1984 is **$19.25** per pound U_3O_8, down $3.25 since last month. The current Transaction Value includes 12 transactions involving a total of 3.2 million pounds U_3O_8 or equivalent UF_6 and covers a period of 5 months.

The **Loan Use Charge Rate** as of March 31, 1984 is **6 percent** per annum, unchanged since last month. No uranium loans are reported.

* * *

The Exchange Value fell $0.50 to $17.00 after an unusually active month of trading. More than 10 spot and near-term transactions, involving nearly 4 million pounds U_3O_8 equivalent, had been concluded or were nearing that stage by the end of March.

In the early part of March prices moved sharply lower, and dipped below $16.00 at mid-month before showing signs of recovery. Selling was dominated by utility and producer inventory holders intent on liquidating their stocks. Their willingness to offer prices below the $17.00 level elicited from producers as well as utilities a number of inquiries to purchase. The spot and near-term demand for natural uranium rose by more than 50 percent, to 3.8 million pounds.

The burst of activity that took place in early and mid-March seemed to clear the market temporarily of distress sellers. At the end of the month business could be concluded at or near the current Exchange Value, and few if any active sellers were willing to offer at prices much below that level. Given the current situation, three market scenarios seem plausible in the near future.

1. If buyers sense an end to the availability of bargain-priced inventory, they could seek business assertively, and prices could rebound sharply.
2. If the current level of supply remains stable and buyers continue to purchase with discretion, prices could remain stable near the $17.00 level.
3. If holders of large quantities of unneeded inventory, some of whom are not presently active, enter the market and cause a resumption of distress selling, prices could move downward again.

While the Exchange Value bottomed at $17.00 for two months in the third quarter of 1982, there is no reason to assume that it will not fall below that level in the future. Large amounts of inventory and excessive production are still present in the market, if not actively for sale. Economic, political and legal events external to the uranium market could release for liquidation much more inventory, which in turn could overwhelm demand.

* * *

The **Conversion Value** as of March 31, 1984 is **$0.80** per pound U as UF_6, up $0.50 since last month. This Report lists one conversion transaction, involving 50-100 thousand pounds U as UF_6. Active secondary market supply of conversion services for delivery within three years totals 3.6 million pounds U as UF_6, while active demand is approximately 65 thousand pounds.

The recovery of the Conversion Value during March was based on the withdrawal from the market of conversion sellers previously willing to swap natural UF_6 for U_3O_8 in exchange for minimal compensation for the conversion component of their UF_6. The current active sellers have available for sale a large amount of supply, but their offering prices appear to be stable at or near the current Value. The limited conversion demand is firm.

SECONDARY MARKET ENRICHMENT SERVICES

The secondary market **SWU Values** as of March 31, 1984 are **$100** for DOE origin and **FY85** delivery, and **$80** for **non-DOE origin** and delivery within approximately 15 months. The *Current Market Data* section of this Report lists ten secondary market SWU transactions involving a total of 630 thousand SWUs. Active secondary market supply of enrichment services totals approximately 1.5 million SWUs, while active demand amounts to 860 thousand SWUs.

* * *

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PRICING

Nuexco begins publishing a FY85 DOE origin SWU Value this month to reflect the concentration of activity in the market for FY85 deliveries rather than FY84. As of March 31, the market for FY84 SWUs is largely gone due to DOE's standard requirement of 180 days' notice prior to deliveries. In general, after March 31 a buyer seeking FY84 delivery from DOE must find a seller that has already ordered the desired enrichment assay, or that has in inventory product enriched to such a level.

Although ten secondary market SWU transactions are reported this month, and eight of those involve SWUs of DOE origin, it is difficult to characterize the secondary market for DOE origin SWUs at the present time because of the rather moderate response to date to the Utility Services enrichment contract (USEC). The activity taking place is in the range of $100 per SWU; precise offering prices have varied somewhat, largely because of varying tails specifications.

The demand for FY85 DOE origin SWUs comes from two classes of utilities:

1. Holders of Requirements contracts that intend to convert to the USEC; they can purchase up to 30 percent of requirements in the secondary market for DOE origin SWUs.

2. Holders of modified Interim Sales Contracts (ISCs); these few utilities can purchase up to 60 percent of FY85 requirements in the secondary market for DOE origin SWUs. Holders of modified ISCs are obligated to convert to the USEC if the USEC's terms are "no less favorable than those in the customer's existing Requirements-type contract when considered in its entirety."

Most Requirements contract holders have not yet made a final decision regarding the USEC because it is not clear that the USEC is a better bargain. Approximately 15 utilities have sent DOE letters of intent to convert to the new contract (only Duke Power has actually signed a USEC), but these customers are for the most part holders of Adjustable, Fixed-Commitment (AFC) contracts, for whom the USEC is an obvious improvement. Nuexco has calculated that AFC holders have excessive commitments to DOE amounting to over three million SWUs for FY85 alone, all of which is potential supply for the near-term secondary market.

One of the factors affecting Requirements customers' decisions to convert to the USEC will be the published price for SWUs under Requirements contracts (the new Requirements contract price, published on April 4, is $157, $22 more than the current USEC price of $135). However, a more important factor may be the question of economical long-term enrichment supply. Many Requirements contract holders undoubtedly are looking at the benefits associated with terminating their contracts and filling their future requirements with SWUs of non-DOE origin.

Indeed, several Requirements contract holders in the USA, Europe and Japan have already terminated contracts for several million SWUs in FY85 alone. To whatever extent those terminated SWUs were to have filled requirements, they constitute potential demand for non-DOE origin SWUs.

* * *

The **non-DOE origin SWU Value** declined $3 to $80 during March, as competition increased among non-DOE sellers to attract the business of utilities not yet committed to a primary enricher for the bulk of future SWU deliveries. DOE has made clear its wish to forestall utilities converting to the USEC from purchasing SWUs of non-DOE origin for deliveries prior to FY87. Thus, non-DOE suppliers have offered especially attractive terms in an effort to induce current DOE customers to forego future commitments to DOE. Sellers of secondary market non-DOE origin SWUs have in recent weeks been joined in their marketing efforts by primary market sellers, all hoping to increase their shares of the enrichment market.

DOE SWU PRICES (APRIL 4, 1984)

The Federal Register of the US Government has published the following new DOE SWU prices, which become effective 180 days after publication.

USEC:	$135
Commitments:	$153
Requirements:	$157

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BIDS, OFFERS AND INQUIRIES

Introduction

As indicated in the *Pricing* section of this Report, the spot and near-term markets for natural uranium and for secondary market enrichment services have been unusually active during the past few weeks. In times such as these, when markets are tight, prices are fluctuating, or transactions are being concluded rapidly, knowledge of the precise meaning of terms and their correct usage greatly clarifies the mechanics of buying and selling uranium. The following paragraphs will review the meaning and usage of **bid, offer,** and **inquiry,** three terms that apply directly to the spot and near-term markets. The substance of these paragraphs appeared in earlier Nuexco Reports, most recently several years ago.

Bids and Offers

The use of the terms *bid* and *offer* by uranium market participants reflects standard security market and commodity market language. A *bid to buy*, or bid, is a recitation of definite terms under which one party expresses its assent to purchase certain material from another party. An *offer to sell*, or offer, is a recitation of definite terms under which one party expresses its assent to sell certain material to another party. Both bids and offers typically specify type of material, quantity, source, delivery location, delivery date, specifications, price, payment terms, validity date and any other conditions required by the bidder or offerer. The responses to an offer parallel those outlined below for a bid.

A party in receipt of a bid may do one of four things:

1. **Accept** the bid, in which case negotiations toward a final contract may proceed.

2. **Reject** the bid, in which case the bid is nullified. Upon receipt of a bid rejection, the bidder may withdraw from negotiations with the original party or submit an amended bid containing other terms. The bidder may also submit the original bid, or an amended bid, to one or more new parties, or resubmit the original bid to the original party, or choose some combination of the above options.

3. **Ignore** the bid, in which case the bidder may revoke the bid, or the bid may expire, either by operation of law or by an expiration date.

4. **Counter** the bid, in which case the party rejects the buyer's bid but specifies acceptable terms in a *counter-offer*. Upon receipt of a counter-offer, the original bidder may accept it, reject it, ignore it, or make a counter-bid.

When making bids and offers, the parties doing so must be aware that their bids and offers are subject to acceptance and that such acceptance, at the very least, obligates the parties to enter good faith negotiations towards a final contract. At the other extreme, such acceptance may carry with it the obligation of specific and immediate performance. The nature of the obligation resulting from acceptance is a function of the complexity and type of transaction. In the case of a straightforward transaction involving immediate delivery and payment, a bid or offer accepted in timely fashion by the party to whom the bid or offer was made may constitute an enforceable contract. In more complex or longer-term transactions, bids and offers may contain specific contingencies such as requirements for Board of Directors' approval, or particular terms or language specifically intended for resolution in subsequent negotiations, the objective of which is agreement on a formal contract document.

Thus, bids and offers should be sufficiently complete such that all the potential issues between the parties are at least acknowledged, if not settled. New demands that appear suddenly in final negotiations are unsettling and often lead to termination of negotiations.

Inquiries

Bids and offers by definition carry binding obligations to pursue a specific course of action, if accepted. All other approaches to the market by prospective buyers and sellers are termed inquiries.

1. The most familiar type of inquiry is the *competitive bid invitation* issued by utility companies. (This term is, of course, a misnomer, for what the utility actually does in issuing the invitation is to solicit *offers* from uranium sellers.) The reverse of the utility's competitive invitation is the *seller's auction,* in which the seller advises prospective buyers that certain material is available for sale, and invites them to bid for it.

In order for a utility's invitation or a seller's auction to be successful, the market must be stable or skewed in favor of the initiating party. "Success" in this context implies a number of responses reflecting a range of prices, terms and conditions from which the initiating party may choose. Maximum success (highest price for the seller or lowest price for the buyer) normally occurs when a strong market imbalance exists in favor of the initiating party. Thus, in a sellers' market characterized by excess demand and rising prices, the seller has the best opportunity to

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obtain a high price for his material. For the same reasons, a utility's competitive invitation has little chance of eliciting interesting offers to sell in a sellers' market.

Conversely, in a buyers' market, characterized by excess supply and falling prices, a seller's auction would be expected to draw scant attention and sellers would, instead, be expected to compete aggressively in response to any competitive invitations issued by prospective buyers.

2. A second type of inquiry is the *direct inquiry*, in which the prospective buyer (or seller) approaches the other party directly with the intent of negotiating a transaction without going through the competitive procedure outlined above.

While this approach often contains elements of the firm-bid, firm-offer approach, the negotiations do not typically start from such a formal position, but rather from a more generalized position such as, "I'd like to discuss my 1982–1992 requirements with you," or "You may be interested in some material I will have available for sale in the 1981–1987 period." The fact that one party has initiated the inquiry implies that he would like to do business. The discussions that follow are often a series of bids and offers that the participants make as they search for common ground.

The direct inquiry is most apt to be used when:

a. the initiating party has greater than average market sophistication, and feels confident enough of his market knowledge to ignore other potential buyers (or sellers) in favor of concentrating on what is deemed the most likely target;

b. a previous contractual relationship has existed or the parties have an ongoing relationship of some kind;

c. a competitive invitation or seller's auction has produced unsatisfactory responses;

d. the initiating party, for any number of reasons, wishes to protect his identity or conceal the fact that he is in the market.

The number and frequency with which these various approaches are used depends on the state of the market. What is effective in a sellers' market probably will not work in a buyers' market. However, effective marketing and procurement require that market participants understand the meaning, timeliness and application of these various approaches.

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EXCHANGE VALUE $17.00/lb. U_3O_8
Determined as of March 31, 1984

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE[1]
Determined as of March 31, 1984

$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
19.25	3.2	12	5

Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in:

A. Transactions closed within the previous three-month period for which delivery was scheduled within one year of the transaction date;
B. At least ten transactions;
C. Transactions involving a sum total of at least two million pounds U_3O_8 equivalent.

The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars as of the transaction date.

Comments

Nuexco does not consider the following in determining the Transaction Value:

A. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.
B. The price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of Exchange Value or any other independent variable.
C. Transactions in which the delivery price is defined in such a way that it cannot currently be determined.

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[1] Transaction Values for 1976 through 1981 and their associated parameters (millions of pounds, number of transactions and number of months) are tabulated on pages 31 and 32 of Report 161. The corresponding data for 1982 are tabulated on page 5 of Report 173, and for 1983 on page 5 of Report 186.

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CURRENT MARKET DATA

LOAN USE CHARGE RATE[1] 6%
Determined as of March 31, 1984

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrows and lenders have expressed as a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

[1] Monthly data for 1968 through 1981 appear on pages 32–34 of Report 162. Monthly data for 1982 appear on page 2 of Report 173.

CONVERSION VALUE $0.80/lb. U as UF_6
Determined as of March 31, 1984

Definition

The Conversion Value is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.

Derivation

Nuexco bases the Conversion Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Conversion Value:

A. The price of conversion services delivered or to be delivered under old contracts.
B. The price of conversion services delivered in connection with contract renegotiations or other than arm's length transactions.
C. Transportation charges other than those customarily provided by primary suppliers of conversion services.

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CURRENT MARKET DATA

SWU VALUES

$100/SWU FOR DOE ORIGIN AND FY85 DELIVERY
$80/SWU FOR NON-DOE ORIGIN AND DELIVERY WITHIN 15 MONTHS
Determined as of March 31, 1984

Definition

The SWU (Separative Work Unit) Values represent Nuexco's judgment of the price, expressed in US dollars per SWU, at which transactions for the sale of significant quantities of SWUs of stated origin for delivery in the specified time period could be concluded as of the date indicated.

Derivation

Nuexco bases the SWU Values upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.
E. SWU prices at varying tails assays and varying product assays are converted to the equivalent SWU price at the DOE Reference Transaction Tails Assay (presently 0.20 weight percent U_{235}) and a product assay of 3.0 weight percent U_{235} assuming feed costs calculated using the Nuexco Exchange Value and Nuexco Conversion Value determined as of the last day of the same month.

Comments

Nuexco does not consider the following in determining the SWU Values:

A. The price of SWUs delivered under long-term contracts from primary suppliers, such as DOE, Urenco, or Eurodif.
B. The price of SWUs delivered under other than arm's length transactions.

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CURRENT MARKET DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
	This Month (Mar. 31, 1984)	Last Month (Feb. 29, 1984)	12 Months Ago (Mar. 31, 1983)	This Month (Mar. 31, 1984)	Last Month (Feb. 29, 1984)	12 Months Ago (Mar. 31, 1983)
Australia (dollar)	18.12	18.54	25.68	47.11	48.20	66.76
Belgium (comm. franc)	905	933	1,070	2,353	2,426	2,781
Canada (dollar)	21.73	21.89	27.39	56.50	56.91	71.21
Finland (markka)	94.34	98.65	121.72	245.26	256.46	316.44
France (franc)	135.24	140.00	161.82	351.60	363.97	420.69
FRG (mark)	43.92	45.50	54.02	114.17	118.29	140.43
Italy (lira)	27,490	28,262	32,246	71,469	73,476	83,833
Japan (yen)	3,805	4,084	5,336	9,892	10.618	13,872
Netherlands (guilder)	49.53	51.33	60.89	128.78	133.46	158.31
South Africa (rand)	21.01	21.02	24.36	54.63	54.65	63.32
Spain (peseta)	2,518	2,611	3,048	6,547	6,788	7,924
Sweden (krona)	130.87	135.98	167.42	340.23	353.50	435.25
Switzerland (franc)	36.37	37.82	46.18	94.56	98.33	120.06
UK (pound)	11.71	11.71	15.16	30.43	30.44	39.40
US (dollar)	17.00	17.50	22.25	44.20	45.50	57.85

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
	This Month (Mar. 31, 1984)	Last Month (Feb. 29, 1984)	12 Months Ago (Mar. 31, 1983)	This Month (Mar. 31, 1984)	Last Month (Feb. 29, 1984)	12 Months Ago (Mar. 31, 1983)
Australia (dollar)	20.52	23.84	24.64	53.34	61.97	64.06
Belgium (comm. franc)	1,025	1,200	1,026	2,665	3,120	2,669
Canada (dollar)	24.61	28.15	26.28	63.97	73.17	68.33
Finland (markka)	106.83	126.83	116.79	277.72	329.73	303.64
France (franc)	153.14	180.00	155.27	398.14	467.96	403.67
FRG (mark)	49.73	58.50	51.83	129.28	152.09	134.75
Italy (lira)	31,129	36,337	30,942	80.928	94,469	80,442
Japan (yen)	4,308	5,251	5,120	11,201	13,651	13,311
Netherlands (guilder)	56.09	66.00	58.43	145.82	171.59	151.90
South Africa (rand)	23.79	27.03	23.37	61.86	70.26	60.76
Spain (peseta)	2,851	3,357	2,925	7,413	8,728	7,603
Sweden (krona)	148.19	174.83	160.65	385.26	454.51	417.65
Switzerland (franc)	41.19	48.63	44.31	107.07	126.42	115.20
UK (pound)	13.26	15.06	14.54	34.46	39.14	37.81
US (dollar)	19.25	22.50	21.35	50.05	58.50	55.51

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[1] Calculated using currency exchange rates published in the *Wall Street Journal* on March 30, 1984.

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CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

	per lb. U as UF_6			per kg. U as UF_6		
Country (currency)	**This Month (Mar. 31, 1984)**	**Last Month (Feb. 29, 1984)**	**12 Months Ago (Mar. 31, 1983)**	**This Month (Mar. 31, 1984)**	**Last Month (Feb. 29, 1984)**	**12 Months Ago (Mar. 31, 1983)**
Australia (dollar)	0.85	0.32	1.62	1.88	0.70	3.56
Belgium (comm. franc)	42.60	16.00	67.31	93.91	35.27	148.39
Canada (dollar)	1.02	0.38	1.72	2.25	0.83	3.80
Finland (markka)	4.44	1.69	7.66	9.79	3.73	16.88
France (franc)	6.36	2.40	10.18	14.03	5.29	22.45
FRG (mark)	2.07	0.78	3.40	4.56	1.72	7.49
Italy (lira)	1,294	484.50	2,029	2,852	1,068	4,473
Japan (yen)	179.05	70.01	335.73	394.74	154.35	740.16
Netherlands (guilder)	2.33	0.88	3.83	5.14	1.94	8.45
South Africa (rand)	0.99	0.36	1.53	2.18	0.79	3.38
Spain (peseta)	118.50	44.76	191.78	261.25	98.69	422.80
Sweden (krona)	6.16	2.33	10.53	13.58	5.14	23.22
Switzerland (franc)	1.71	0.65	2.91	3.77	1.43	6.41
UK (pound)	0.55	0.20	0.95	1.21	0.44	2.10
US (dollar)	0.80	0.30	1.40	1.76	0.66	3.09

SWU VALUES EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU FY85	Non-DOE SWU delivery within 15 months
Australia (dollar)	106.59	85.27
Belgium (comm. franc)	5,325	4,260
Canada (dollar)	127.83	102.26
Finland (markka)	554.94	443.95
France (franc)	795.54	636.44
FRG (mark)	258.33	206.66
Italy (lira)	61,708	129,366
Japan (yen)	22,381	17,905
Netherlands (guilder)	291.38	233.10
South Africa (rand)	123.61	98.89
Spain (peseta)	14,813	11,850
Sweden (krona)	769.82	615.86
Switzerland (franc)	213.95	171.16
UK (pound)	68.86	55.09
US (dollar)	100.00	80.00

[1] Calculated using currency exchange rates published in the *Wall Street Journal* on March 30, 1984.

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CURRENT MARKET DATA

RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
2776	1984-85	50-100	99-102	US Producer	US Utility	Fixed prices.
2775	1984	301-600	97	US Producer	European Utility	Inventory sale.
2773	1984	less than 50	91	European Entity	US Utility	UF_6. Inventory sale.
2769	1985	601-1,000	97	US Utility	European Broker	UF_6. Inventory sale.
2767	1984	101-300	85	US Utility	European Utility	UF_6. Inventory sale.
2766	1984-85	101-300	99-111	Canadian Producer	US Producer	Fixed prices.
2762	1984	101-300	indeterminate	European Entity	Far East Utility	Enriched UF_6. Included approximately 90,000 SWUs.
2737	1984	101-300	98	US Producer	US Producer	Inventory sale.
2736	1984	101-300	98	US Producer	US Utility	Inventory sale.

Secondary Market Conversion Services

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U equivalent)	Approximate Price as Percent of Current C.V.	Seller	Buyer
2685	1984	50-100	38	European Entity	US Utility

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Secondary Market Enrichment Services

Nuexco Transaction Number	Delivery Period[2]	Approximate Quantity (thousands of SWUs)	Approximate Price[3] as Percent of Current SWU Value[4]	Tails Assay (Percent U_{235})	Seller Group	Buyer Group	SWU Origin	Remarks
2777	1986	50-100	indeterminate	to be determined	European Utility	US Utility	DOE	Discount from DOE price.
2774	1985	less than 50	98	0.25	European Entity	US Utility	Eurodif	
2772	1987	50-100	124	to be determined	European Entity	US Utility	Eurodif	Fixed price.
2771	1985	50-100	102	0.3	US Utility	US Utility	DOE	
2770	1984	50-100	99	0.2	US Utility	US Utility	DOE	
2768	1984	50-100	100	0.3	US Utility	US Utility	DOE	
2735	1984	50-100	unknown	unknown	US Utility	US Utility	DOE	Not arm's length.
2734	1986	less than 50	110	0.2	US Utility	Japanese Utility	DOE	Fixed price.
2733	1986	101-300	indeterminate	to be determined	European Utility	US Utility	DOE	Discount from DOE price.
2711	1984	less than 50	105	unknown	US Utility	US Utility	DOE	

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[1] Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.
[2] Refers to calendar year, not fiscal year.
[3] Price is not normalized to 0.20% tails assay.
[4] Refers to SWU Value for same origin as SWUs included in transaction.

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CURRENT MARKET DATA

URANIUM SUPPLY
(As of 3/31/84)

	Delivery Period[1] (Thousands of Pounds U_3O_8)		
Nuexco Project Number	Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
1575	—	500 per year	
1818	—	500 per year	
2038	1,000	—	UF_6
2134	—	250 per year	1984-87
2201	95	—	
2236	—	200 per year	1985-89
2263	—	500 per year	1985-90
2275	135	—	
2297	—	200 per year	1985-89
2307	880	—	UF_6
2315	450	950	UF_6
2320	330	—	UF_6
2326	—	3,500	1988-91
2335	275	—	
2336	—	250 per year	
2365	20	—	
2368	—	2,800	
2376	50	—	
2389	300	—	
2390	100	—	
2392	35	—	UF_6
2436 A	850	—	enriched UF_6
2483 A	545	—	
2484	130	—	
2557	860	—	
TOTAL:	6,055		
INACTIVE			
0564	—	1,000 per year	1986-91
2017	1,100	1,200	
2191	125	—	UF_6
2193	—	800 per year	1986-90
2271	—	500 per year	1984-88
2429	450	—	
2473	—	500 per year	1984-88
TOTAL:	1,675		

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[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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URANIUM DEMAND
(As of 3/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	 Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2118	300	—	
2217	—	1,000 per year	1988-95
2302	—	330 per year	1988-94
2310 A	500	—	enriched UF_6
2329	—	500	1985
2352	300	—	
2355 A	—	1,400	enriched UF_6
2411	500	—	
2419	130	—	
2445	—	250 per year	1988-93
2456	650	—	UF_6
2463	260	—	UF_6
2468	310	—	UF_6
2470	780	—	UF_6
2502	60	—	
2558	—	235	1985 UF_6
2559	—	800	1987
TOTAL:	3,790		
INACTIVE			
1999	—	50 per year	1985-90
2244	—	350 per year	
2303	—	275 per year	1985-90
2372	—	100 per year	1985-88
2413	—	250 per year	1987 on
2414	—	150 per year	1987 on
2457	—	650	1987
2478	400	—	
TOTAL:	400		

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[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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CURRENT MARKET DATA

LOAN SUPPLY AND DEMAND
(As of 3/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Within 1 Year	 Beyond 1 Year	Remarks
Available for Loan:			
ACTIVE			
2128	1,000	—	
2139	2,000	—	
2483 B	545	—	
TOTAL:	3,545		

CONVERSION SUPPLY AND DEMAND
(As of 3/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF_6) Within 3 Years	 Beyond 3 Years	Remarks
Available for Sale:			
ACTIVE			
2051	1,000	—	
2141	2,200	—	
2397	200	—	
2438	220	220	1985-87
TOTAL:	3,620		
INACTIVE			
1936	1,000	—	
2401	600	—	
TOTAL:	1,600		
Inquiries to Purchase:			
ACTIVE			
2397	65	—	
TOTAL:	65		
INACTIVE			
2420	300	—	1986
TOTAL:	300		

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[1] Measured from the date of this Report.

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SWU SUPPLY
(As of 3/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
2100	—	100 per year	1986-87
2189	80	—	
2192	100	210	1986-87
2210	100	—	
2285	500	3,000	
2345	150	—	
2351	—	250 per year	1986-88
2378	130	250 per year	1987-88
2408	160	—	
2428	80	—	
2436 B	185	—	enriched UF_6
2469	—	80	1987
TOTAL:	1,485		
INACTIVE			
2337	250	250	
2359	180	—	
2375	200	—	
TOTAL:	630		

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[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

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CURRENT MARKET DATA

SWU DEMAND
(As of 3/31/84)

	Delivery Period[1] (Thousands of SWUs)		
Nuexco Project Number	Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2310 B	110	—	enriched UF_6
2346	—	30 per year	
2355 B	—	600	enriched UF_6
2372 A	120	30 per year	1986-90
2400	80	—	
2407	75	130	1986
2412	85	—	
2422	—	2,000	1985-94
2448	25	—	
2452	30	—	1985
2458	—	60 per year	1987-91
2465	—	400	1987-90
2475	300	300 per year	1988-90
2491	—	80 per year	1987 on
2496	35	35	1986
2503	—	330	1986
TOTAL:	860		
INACTIVE			
2142	35	15	1986
2237	—	250 per year	1987 on
2432	50	500	
2440	—	20 per year	1988-91
2449	50	—	
2459	50	50 per year	
2471	60	40 per year	
2567	—	45 per year	1987 on
TOTAL:	245		

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

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AUSTRALIA

The Minister of Resources and Energy, Senator Walsh, has prepared a draft uranium policy that his party faction will propose at the Australian Labor Party (ALP) National Conference in July. The policy, if adopted, will provide the government flexibility to approve the expansion of the Australian uranium industry. The four points of the policy are:

1. To allow uranium export under stringent non-proliferation safeguards;
2. To withhold uranium exports from countries that do not observe non-proliferation conditions (including France, until France halts weapons testing in the South Pacific);
3. To support research and development of technology for high-level waste disposal;
4. To insure health standards, monitoring and protection of workers in the uranium industry.

Conspicuously absent from this policy is any commitment to limit the future development of uranium deposits. The federal government's existing policy, approved in November by the ALP caucus, specifically precludes development of any new uranium-producing mines except for the Olympic Dam deposit at Roxby Downs Station in South Australia. The Walsh proposal, representing the position of the center-left of the ALP, is a more positive, forward-looking stance than the existing policy, and is close to the view of Prime Minister Hawke (who would, however, prefer a more flexible position toward France). Rather than categorically oppose nuclear energy and withdraw from the uranium trade, the government in essence would support the beneficial aspects of nuclear energy while taking action to remedy the negative aspects.

How the proposal will be received at the Party conference is unclear. The anti-uranium wing of the ALP is vocal and stubborn. However, Prime Minister Hawke enjoys broad electoral support in Australia at the present time, and he continues to draw fresh support for his centrist policies from former opponents. Undoubtedly the objectives of Party unity and a display of confidence in the current leadership will favor the acceptance of the Walsh proposal.

Nevertheless, even if the Australian Labor government were to adopt such a stance formally, the prospects for the country's uranium industry would not be promising. Worldwide production, notably from new high-grade sources outside Australia, continues to exceed consumption by a margin of more than 15 million pounds annually, sustaining the growth in inventories. Prices are low and utilities' unfilled requirements are declining. Given this situation, there is little immediate incentive for prospective Australian producers to rush into the market. On the other hand, holding back now can only hurt their chances of gaining business that may arise in the long term.

JAPAN

Report 186 (February 1984) summarized the status of commercial nuclear power plants in Japan. In the subsequent two months, further progress has been achieved and modifications have been made to the expected commercial operation dates of several units.

Tokyo Electric Power's (TEPCO) Fukushima Unit II-2, an 1,100-MWe BWR, achieved commercial operation status on February 3, 1984. The event officially increased TEPCO's nuclear generating capacity to 6,896 MWe, 19 percent of the utility's total electricity generating capacity. The plant also increased the total number of nuclear units in commercial operation in Japan to 25, representing cumulative capacity of 18,277 MWe.

Onagawa Unit 1, a 524-MWe BWR owned by Tohoku Electric Power Company, and Sendai Unit 1, an 890-MWe PWR owned by Kyushu Electric Power Company, are undergoing power range testing. Commercial operations are expected in June and July 1984, respectively. Fuel loading is scheduled later this year for Takahama Unit 3, an 870-MWe PWR owned by Kansai Electric Power Company (Kansai); its commercial operation date is scheduled for February 1985. With the addition of these three units within the coming year, total nuclear generating capacity in Japan will exceed 20,000 MWe.

Several planned facilities have progressed toward licensing. TEPCO officially announced its intention to proceed with two additional 1,100-MWe BWRs, Kashiwazaki Units 3 and 4. The units, having scheduled commercial operation dates of mid-1993 and mid-1994, now enter the official planning stage. TEPCO expects the plans to be submitted to the Electric Power Resources Development Coordination Council (EPRDCC) early in 1985. (See the article in this Report entitled *Plant Licensing in Japan.*)

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Kansai concluded successful negotiations with local governments to proceed with two 1,180-MWe PWRs, Ohi Units 3 and 4. Initial public hearings will be held within the next few months; submission for EPRDCC approval will be made this year. Respective operation dates for these two plants are mid-1990 and mid-1991.

Citing lower than predicted load growth, Hokkaido Electric Power Company announced delays for commercial operation of its first two nuclear reactors, Kyowa-Tomari Units 1 and 2, both 519-MWe PWRs. Commercial operation will be delayed six months for each, to June 1989 and June 1991.

* * *

The first nuclear power unit to operate commercially in Japan was Tokai Unit 1, a 166-MWe gas-cooled reactor that started operation in 1966. Its owner, Japan Atomic Power Company (JAPC), recently announced plans to undertake a major refurbishment program to increase the efficiency of the unit and extend its useful life for at least another decade. For some time, 18-year-old Tokai Unit 1 has been a candidate for decommissioning. JAPC decided against decommissioning primarily for two reasons.

1. Japan lacks adequate regulatory guidelines and current techniques for nuclear plant decommissioning.
2. Decommissioning could have had a psychologically negative effect in Japan at a time when the electricity generation industry is emphasizing to the public the advantages of nuclear energy.

* * *

In general Japan's utilities have reacted favorably to DOE's offer of the Utility Services enrichment contract (USEC). Their major concern regarding the contract, aside from pricing, seems to be how to adjust with DOE their requirements. The utilities have contracts with Eurodif to supply approximately 10 percent of requirements through 1990. They plan to take from their own domestic enrichment program approximately one million SWUs by the mid-1990s, and three million SWUs by the year 2000. In mid-March the Federation of Electric Power Companies announced that it intends the domestic enrichment program ultimately to provide one-third of commercial requirements.

Considering that the Japanese utilities are a huge source of business, DOE is likely to accommodate their concerns in order to maintain its dominant share of the Japanese market. DOE personnel recently have been discussing the USEC with utility personnel in Japan. Concurrently, however, European enrichment suppliers have been marketing in Japan as well. At least one European supplier has claimed to offer contract terms and conditions superior to those of the USEC.

SOUTH AFRICA

Palabora Mining Company (PMC) produced 482,000 pounds U_3O_8 in 1983, according to an announcement in late March. Adding the PMC figure to the 15,290,000 pounds produced at other operations (detailed on page 30 of Report 186) brings total 1983 South African U_3O_8 production to 15,772,000 pounds. PMC's U_3O_8 output, a by-product of its copper mining operations, declined by 15 percent from the 1982 level of 568,500 pounds, largely because of the variable grade of the carbonatite orebody.

* * *

On March 12 Harmony Gold Mining Company Ltd. announced the closure of its Merriespruit uranium recovery plant. The plant, commissioned in 1980 and one of three that Harmony operates, processed approximately 28 percent of Harmony's total 1983 U_3O_8 output of 1,374,000 pounds. According to the company announcement, production from the other two plants, together with the existing U_3O_8 stock, is sufficient to meet long-term committed sales. The announcement cited low uranium prices as the reason for the closure.

At the Merriespruit mine, ore is treated first for gold recovery at the Merriespruit gold plant. Slimes are then sent to the uranium plant for uranium recovery. The slimes from the uranium plant are finally pumped into tailings dams. When the uranium plant is closed, the gold plant slimes will be pumped to a new slimes dam to preserve the uranium-bearing material.

Harmony is the third South African uranium producer this year to announce plans to curtail operations. Blyvooruitzicht is planning to cease U_3O_8 production in August from its Number 6 slimes dam. Western Deep Levels, the country's smallest uranium producer, is considering converting its uranium plant to gold treatment. According to a company statement, conversion to a gold-treatment facility would greatly increase the plant's contribution to profits. If and when Harmony, Blyvooruitzicht and Western Deep Levels all cut back on uranium production, South Africa's production rate could be reduced by almost 10 percent.

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SPAIN

The government of Spain has announced the nation's new official nuclear energy plan. The new plan reduces the previous official capacity projection by providing for the indefinite deferral of five units that are under construction and two that were planned. Among the units shelved indefinitely are the twin Lemoniz PWRs in the Basque country, one of which is nearly complete and the other of which is almost 60 percent complete. Also deferred are Valdecaballeros Units 1 and 2 and Trillo Unit 2, which are in the early stages of construction. The government is now deciding how to cope with the financial implications of its decision. Only after the financial losses have been determined will the question of fuel pre-purchases be approached.

There are six units in commercial operation in Spain, and two others (Cofrentes and Asco Unit 2) are scheduled to begin commercial operation within the year (Table 1). Of the seven other units under construction, only two, Trillo Unit 1 and Vandellos Unit 2, have been approved. The government plan calls for ten units to be in commercial operation in 1992, having a total net generating capacity of 7,829 MWe.

Table 1

SPAIN'S CURRENT NUCLEAR PROGRAM

Unit	Utility	MWe Net	Type	COD
Operating				
Zorita[1]	Union Electrica	160	PWR	1968
Garona	Nuclenor	460	BWR	1970
Vandellos 1	Hifrensa[2]	500	GCR	1972
Almaraz 1	HE[3]/UE[4]/CSE[5]	930	PWR	1981
Almaraz 2	HE[3]/UE[4]/CSE[5]	930	PWR	1983
Asco 1	Fecsa[6]/Enher[7]	930	PWR	1983
Approved				
Cofrentes	Hidrola[8]	975	BWR	1984
Asco 2	Fecsa[6]/Enher[7]	930	PWR	1984
Trillo 1	UE[4]/Endesa[9]	1032	PWR	1987
Vandellos 2	Enher[7]/Fecsa[6]	982	PWR	1988
		7,829		
Indefinitely Deferred				**Percent Complete**
Lemoniz 1	Iberduero	900	PWR	97
Lemoniz 2	Iberduero	900	PWR	57
Valdecaballeros 1	HE[3]/CSE[5]	975	BWR	5
Valdecaballeros 2	HE[3]/CSE[5]	975	BWR	2
Trillo 2	UE[4]/Endesa[9]	997	PWR	0
Regodola	Fedeno[10]	1000	PWR	0
Sayago	Iberduero	1075	PWR	0
		6,822		

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[1] Also known as Jose Cabrera.
[2] Hifrensa = Hispano-Francesa de Energia Nuclear S.A.
[3] HE = Hidroelectrica Española S.A.
[4] UE = Union Electrica.
[5] CSE = Compania Sevillana de Electricidad S.A.
[6] Fecsa = Fuerras Electricas de Cataluna S.A.
[7] Enher = Empresa Nacional Hidroelectrica Ribagorzana.
[8] Hidrola = Hidroelectrica Española S.A.
[9] Endesa = Empresa Nacional de Electrica S.A. (Owned by Institutio Nacional de Industria.)
[10] Fuerzas Electricas del Noroeste.

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ANALYSIS & COMMENTARY

US NUCLEAR POWER PLANT BACKLOG

The December 31, 1981 *Nuclear News* "World List of Nuclear Power Plants" showed 91 nuclear power units as under construction or on order in the USA. Two years later, the December 31, 1983 list shows 59 units in these categories; 32 units were cancelled in the intervening two years.

Since the publication of the latest *Nuclear News* list, Cincinnati Gas & Electric announced its intention to convert its Zimmer unit to a coal-fired plant, Public Service of Indiana "withdrew from" (i.e., stopped financial support of) the two-unit Marble Hill project, and Gulf States Utilities Co. officially cancelled River Bend 2. Thus, there are now 55 nuclear units officially under construction or on order. Of these 55 units, the 7 listed in Table 2 have been indefinitely delayed.

Table 2

INDEFINITELY DELAYED NUCLEAR UNITS IN THE USA

Unit	Utility	MWe Net	Type	Percent Complete
Midland 1	Cons. Pwr.	425	PWR	85
Hartsville A-1	TVA	1233	BWR	44
Hartsville A-2	TVA	1233	BWR	34
Yellow Creek 1	TVA	1285	PWR	35
Yellow Creek 2	TVA	1285	PWR	3
WNP 1	WPPSS	1250	PWR	62
WNP 3	WPPSS	1240	PWR	75

Two of the remaining 48 units, Commonwealth Edison's Carroll County Units 1 and 2, are on order, but have had no construction progress made. That leaves 46 units making up the current backlog of nuclear power plants under construction in the USA. Table 3 lists these 46 units in order of completion percentage as of December 31, 1983. The table also shows the completion percentage of each unit as of December 31, 1981, and the progress (expressed in percentage points) made on each unit over the past two years.

A few of the units listed in Table 3, Arizona Public Service's Palo Verde Unit 3 for example, have made extraordinarily good progress over the past two years. Others, for various well-publicized reasons, have made no progress at all. The average change in completion percentage was an increase of 15.6 percent, unexceptional by current international standards. A breakdown of the change in completion percentages is shown in Table 4.

Table 4

CHANGE IN COMPLETION PERCENTAGES OF US BACKLOG SINCE 1981

Change in Completion Percentage	Number of Units
50-60	1
40-49	2
30-39	6
20-29	7
10-19	13
0-9	13
negative	4
Total	46

Table 5 lists the number of units that are currently within each ten-percent range of completion percentages. What is striking is that 29 of the 46 units that comprise the US backlog are more than 80 percent complete. Eighteen units (almost 40 percent) are more than 90 percent complete. Seven of those eighteen are currently licensed for fuel loading and testing and could begin commercial operation during 1984; the remaining eleven could be licensed and operating before the end of 1985.

Table 5

COMPLETION PERCENTAGES OF US BACKLOG

Percent Complete	Number of Units
91-100	18
81-90	11
71-80	3
61-70	6
51-60	2
41-50	2
31-40	0
21-30	3
11-20	1
0-10	0
Total	46

The recent avalanche of negative news for the US nuclear industry could be offset by a string of new units becoming commercial, if the Nuclear Regulatory Commission begins to clear this backlog with licensing approvals. However, recent history suggests that unanticipated problems will cause numerous delays of undetermined length

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Table 3

US NUCLEAR POWER PLANT BACKLOG

Unit	Utility	Percent Complete Jan. 1982[1]	Percent Complete Jan. 1984[2]	Change in Completion Percentage
Diablo 1	PG&E	100	100	0
McGuire 2	Duke Power	95	100	5
Grand Gulf 1	Middle South	95	100	5
WNP 1	WPPSS	87	100	13
LaSalle 2	Commonwealth Ed.	84	100	16
San Onofre 3	So. Cal. Ed.	78	100	22
Susquehanna 2	Penn. P&L	65	100	35
Palo Verde 1	Arizona PS	95	99	4
Waterford 3	Middle South	92	99	7
Shoreham	Lilco	87	99	12
Palo Verde 2	Arizona PS	74	99	25
Catawba 1	Duke Power	87	98	11
Fermi 2	Detroit Ed.	85	98	13
Callaway 1	Union Elec.	76	98	22
Comanche Peak 1	Texas Util. Co.	86	97	11
Watts Bar 1	TVA	77	96	19
Diablo 2	PG&E	91	95	4
Byron 1	Commonwealth Ed.	79	93	14
Perry 1	Capco	79	90	11
Wolf Creek	Kansas G&E	74	90	16
Limerick 1	Phil. Elec.	68	90	22
Seabrook 1	PS New Hamps.	55	89	34
Midland 2	Consumers Power	73	85	12
Harris 1	Carolina P&L	54	85	31
Palo Verde 3	Arizona PS	28	83	55
Clinton 1	Illinois Power	80	82	2
River Bend 1	Gulf States	39	82	43
Millstone 3	Northeast Util.	45	81	36
Hope Creek 1	Pub. Serv. E&G	42	81	39
Beaver Valley 2	Capco	48	78	30
Nine Mile Pt. 2	Niagara Mohawk	37	78	41
Bellefonte 1	TVA	77	76	(1)
Braidwood 1	Commonwealth Ed.	61	70	9
Byron 2	Commonwealth Ed.	63	67	4
Comanche Peak 2	Texas Util. Co.	46	65	19
Catawba 2	Duke Power	37	62	25
Watts Bar 2	TVA	63	61	(2)
Vogtle 1	Southern Co.	32	61	29
Bellefonte 2	TVA	61	57	(4)
Braidwood 2	Commonwealth Ed.	48	54	6
South Texas 1	STP	60	50	(10)
Perry 2	Capco	40	42	2
Limerick 2	Phil. Elec.	30	30	0
Seabrook 2	PS New Hamps.	9	29	20
South Texas 2	STP	23	25	2
Vogtle 2	Southern Co.	9	20	11

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[1] As listed in the *Nuclear News* "World List of Nuclear Power Plants" for December 31, 1981.

[2] As listed in the *Nuclear News* "World List" for December 31, 1983, or other publications.

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ANALYSIS & COMMENTARY

NUCLEAR POWER PLANT LICENSING IN JAPAN

Introduction

Having consistently built plants on schedule and within budget, Japanese utilities have a reputation for efficiency in the implementation of their commercial nuclear power programs. A range of political, economic and cultural explanations may be cited for this success. The most important reason, however, is that licenses for plant construction are not issued until virtually all of the regulatory obstacles to the plant have been cleared. Several years of coordinated planning by utilities and the government precede the issuance of a single license that authorizes both plant construction and operation.

Legislative Background

Two laws passed in 1955 created the foundation for commercial nuclear power in Japan:

1. The *Atomic Energy Basic Law* declared the nation's intent to promote and develop nuclear power, and vested in the Prime Minister and his Cabinet the responsibility to formulate nuclear power policies.
2. The *Law for Establishment of the Atomic Energy Commision* (AEC) created the administrative vehicle to implement the objectives of the Atomic Energy Basic Law.

In the years following passage of these acts, the government passed two additional acts outlining plant licensing and enforcement of state regulations regarding nuclear power plants.

1. Passed in 1957, the *Law for the Regulation of Nuclear Source Materials, Nuclear Fuel Material, and Reactors,* in conjunction with related orders and interpretations, specified that permission to build a nuclear plant must be granted by the Prime Minister, and only after the conclusion of environmental evaluations and the advice of special committees on plant safety. Permission would be granted in the form of a license known as an "Establishment Permit," which would allow at once for both construction and operation (subject to plant inspections at periodic intervals).
2. The *Electric Enterprise Law* of 1964 defined design standards and requirements for equipment, construction, welding, preoperational testing, operation, periodic maintenance, and in-service inspection. It assigned responsibility for enforcement of standards to the Ministry of International Trade and Industry (MITI), which department also monitors the construction and operation of fossil fuel and hydroelectric power plants.

The Planning Process

Nuclear plant licensing in Japan ordinarily takes between one and two years, but a proposed plant does not begin to undergo licensing until after *three to four years of planning.* The Japanese utilities interact closely with the national government in planning to fulfill the power needs of their service territories. Two national government bodies, MITI and the Electric Power Resources Development Coordination Council (EPRDCC), develop and coordinate plans for power supply. MITI establishes Japan's official electricity generating capacity targets after carefully assessing national economic goals and the needs of the utilities. Because of MITI's strategic concern with the Japanese economy, utilities wishing to sell uranium or SWUs must first receive MITI's authorization.

EPRDCC, composed of the Minister for MITI, the Minister of the Economic Planning Agency, and selected representatives of government, industry and academia, performs the following functions during plant planning:

1. Reviews the utility's generation needs;
2. Approves plant generating capacity;
3. Ensures local public acceptance;
4. Guarantees that environmental reviews are adequate;
5. Grants formal approval of a plant site.

Planning is complete when EPRDCC formally approves the plant site proposed by the utility. Thus, licensing only begins after the national government has recognized the desirability of the new plant and approved its siting.

Figure 1 diagrams the steps involved in plant planning. The utility initiates site feasibility studies, emphasizing discussion with the local governments and communities. In selecting a site, the utility conducts a preliminary environmental evaluation and obtains the approval of the Environmental Protection Agency and the local government. Concurrently, the utility attempts to conclude agreements with local interests—for example, fishermen's associations.

Upon receipt of preliminary legal and local governmental clearance for the preferred site, the utility prepares an Environmental Impact Report (EIR) for submission to MITI, which is responsible for environmental reviews of all power plants in Japan. After receiving the EIR, MITI sponsors a public hearing, held in the locale of the proposed site, at which the utility presents its case for the plant. The results of the hearing and of related government reviews of the EIR are submitted to EPRDCC. With the concurrence of the Prime Minister,

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EPRDCC may grant final plant site approval. Upon EPRDCC approval the planned facility becomes an official project ready to undergo licensing.

Licensing

Figure 2 diagrams the licensing steps that follow EPRDCC approval of the plant site. For the first few commercial nuclear power plants built in Japan, MITI undertook sole responsibility for analysis of plant design and safety specifications. Problems that arose with some of those early plants led to public criticism of the licensing process. As a result, the government modified the licensing procedure to include independent reviews of design and safety specifications. Two independent bodies, the Atomic Energy Commission (AEC) and the Nuclear Safety Commission (NSC), now work with MITI in licensing.

The utility first submits plant design and safety specifications to MITI for a thorough evaluation. The specifications and MITI's evaluation are then passed on to the AEC and NSC. The AEC ensures plant conformance to the Atomic Energy Basic Law, and the NSC analyzes the technical soundness of MITI's design and safety evaluation. The NSC sponsors a second public hearing on the plant, also held in the locale of the plant site, at which MITI presents its evaluation of the utility's licensing application. When MITI, the AEC and the NSC all have approved the plant proposal, the Prime Minister of Japan may instruct the Minister of MITI to issue the Establishment Permit, thereby enabling the utility to draft its construction schedule and confirm the plant order.

Construction

Actual groundbreaking may not begin until the details of the plant construction schedule have been approved by MITI, and the local government has issued conventional building permits. Normally the construction permit process takes six to nine months after issuance of the Establishment Permit. The utility may not sign official contracts with its contractors and hardware suppliers until MITI approval and building permits have been granted. However, contractors and vendors are selected long before actual contract signing. They work closely with the utility to prepare the plant design information submitted with the license application. (For information about the industrial groups involved in the construction of nuclear plants in Japan, see *Japan's Nuclear Power Infrastructure* in Report 185 of January 1984.)

Average construction time for a single-unit 1000-MWe nuclear plant in Japan is 54–58 months, the fastest rate in the world. In accordance with the Electric Enterprise Law, MITI oversees all steps of the construction process, monitors preoperational testing, authorizes commercial operation, and subsequently oversees routine maintenance and in-service inspections. Hardware inspections are performed during fabrication at vendor facilities as well as during assembly and installation at plant sites. Generally 6–12 months elapse from the time MITI authorizes fuel loading and low power testing to the commencement of commercial operation.

Summary

While an average of 9–11 years transpires between the time a utility begins planning for a nuclear plant and the date the plant actually begins commercial operation, only half of that time on average is spent in the expensive construction phase. Ordinarily, the schedule for plant construction proceeds as follows:

1. Planning (through EPRDCC approval): 36–48 months;
2. Licensing (through issuance of the Establishment Permit): 12–24 months;
3. Construction scheduling and issuance of building permits: 6–9 months;
4. Plant construction (through loading of first core): 54–58 months;
5. Fuel loading to commercial operation: 6–12 months.

Once the Establishment Permit is issued, there are no superfluous obstacles to commercial operation. In Japan the government and the utilities share the goal of constructing safe and economical power plants expeditiously, unlike the USA and much of the rest of the world, and they have coordinated their efforts to do so.

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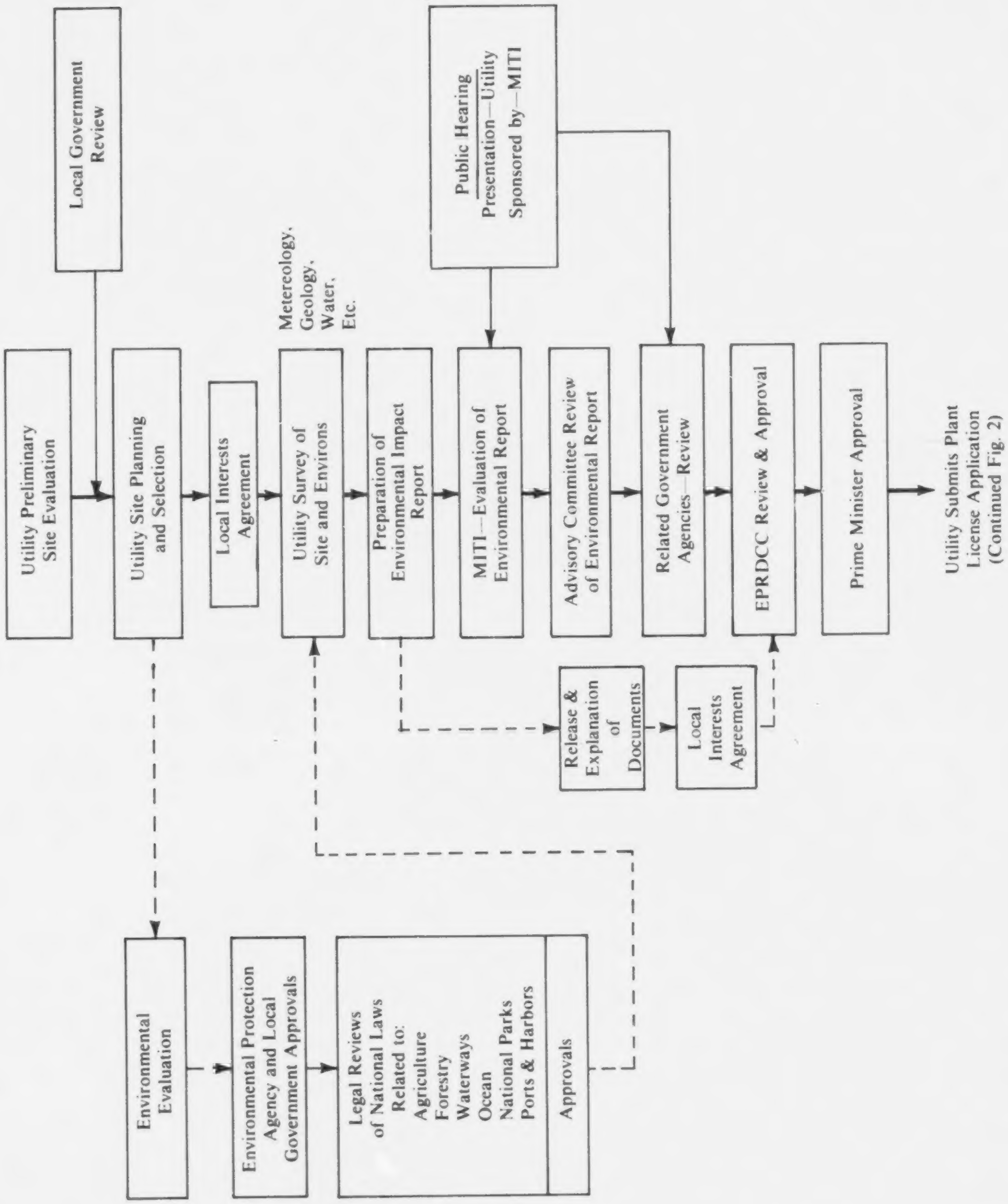
Utility Preliminary Site Evaluation
Local Government Review
Utility Site Planning and Selection
Local Interests Agreement
Metereology, Geology, Water, Etc.
Utility Survey of Site and Environs
Preparation of Environmental Impact Report
Public Hearing
Presentation—Utility
Sponsored by—MITI
MITI—Evaluation of Environmental Report
Advisory Committee Review of Environmental Report
Related Government Agencies—Review
EPRDCC Review & Approval
Prime Minister Approval
Utility Submits Plant License Application (Continued Fig. 2)
Release & Explanation of Documents
Local Interests Agreement
Environmental Evaluation
Environmental Protection Agency and Local Government Approvals
Legal Reviews of National Laws Related to: Agriculture Forestry Waterways Ocean National Parks Ports & Harbors
Approvals

Figure 1

NUCLEAR POWER PLANT PLANNING IN JAPAN

ANALYSIS & COMMENTARY

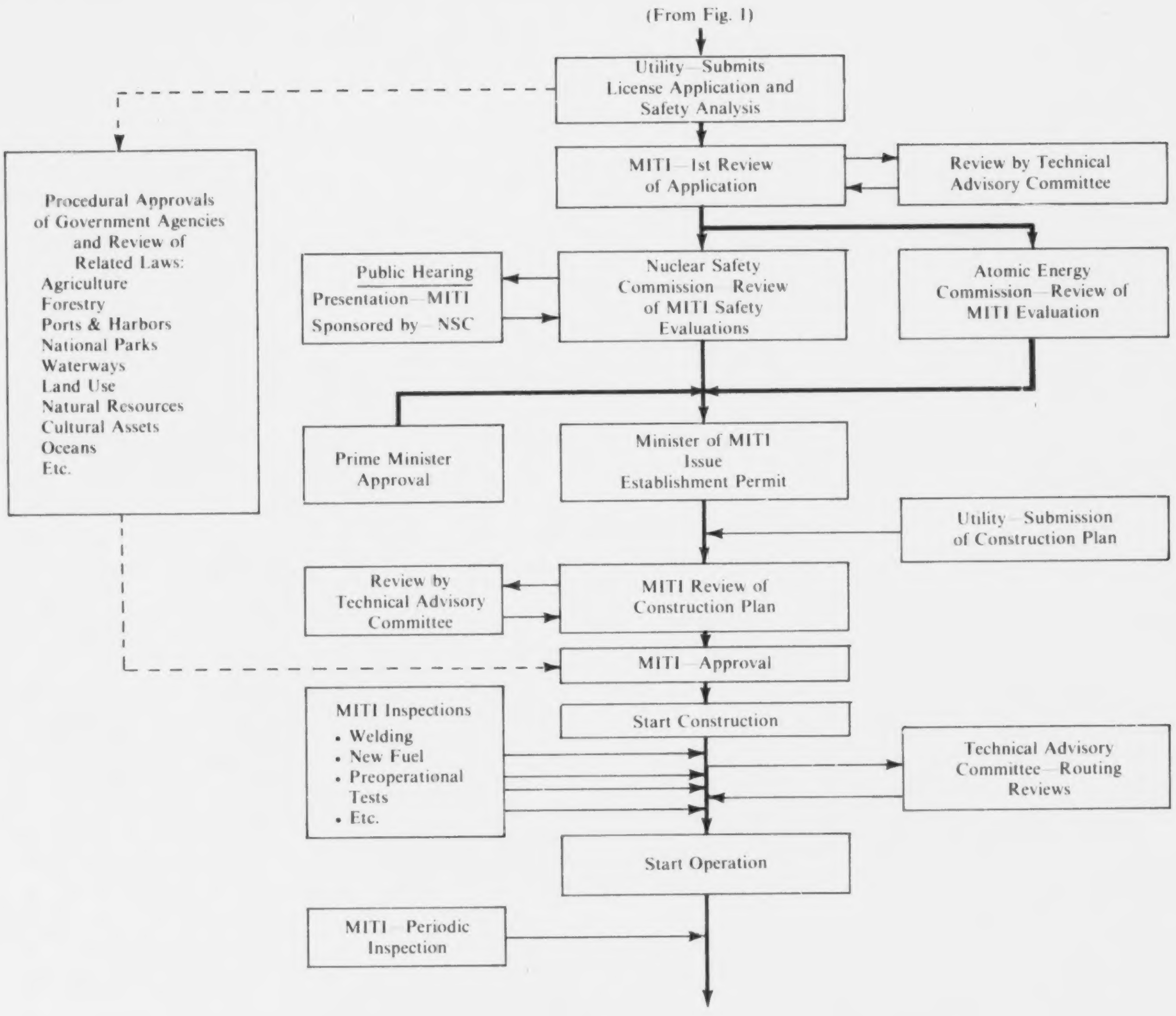
(From Fig. 1)
Utility—Submits License Application and Safety Analysis
MITI—1st Review of Application
Review by Technical Advisory Committee
Procedural Approvals of Government Agencies and Review of Related Laws:
Agriculture
Forestry
Ports & Harbors
National Parks
Waterways
Land Use
Natural Resources
Cultural Assets
Oceans
Etc.
Public Hearing
Presentation—MITI
Sponsored by—NSC
Nuclear Safety Commission—Review of MITI Safety Evaluations
Atomic Energy Commission—Review of MITI Evaluation
Prime Minister Approval
Minister of MITI Issue Establishment Permit
Utility—Submission of Construction Plan
Review by Technical Advisory Committee
MITI Review of Construction Plan
MITI—Approval
MITI Inspections
• Welding
• New Fuel
• Preoperational Tests
• Etc.
Start Construction
Technical Advisory Committee—Routing Reviews
Start Operation
MITI—Periodic Inspection

Figure 2

NUCLEAR POWER PLANT LICENSING IN JAPAN

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EURODIF

Introduction

A consortium of national nuclear fuel companies formed Eurodif in November 1973 to build a uranium enrichment plant that would fulfill the projected enrichment needs of the member nations. Construction on Eurodif's gaseous diffusion plant, located at Tricastin on the lower Rhone River in southern France, began in March 1975. The first two of four separative work process buildings began full operation in April 1979, and the plant reached full nominal capacity of 10.8 million SWUs per year in the second quarter of 1982. Eurodif has operated well below capacity for the past two years because of the excess of supply in the enrichment market.

Overview of Facilities

Eurodif's Tricastin plant spreads out over 2.5 square kilometers of land. Four 900-MWe Pressurized Water Reactors (PWRs) located adjacent to the plant and operated by Electricite de France (EDF) supply the power needed for separative work. The enrichment plant's full-capacity power requirement is approximately 3,000 MWe; its electrical switchyard alone occupies more land (40 hectares) than EDF's adjacent PWR station. An aerial view of the Tricastin site (Figure 3) shows that the dominant features of the Eurodif plant are two 123-meter-high cooling towers. Cooling of the power station condensers is provided by water from the nearby Rhone River.

The four process buildings visible in the center background of Figure 3 have varying sizes and production capacities. All four buildings contain several cells having 20 separation stages each. This compares to 8 or 10 stages per cell at the US Department of Energy's (DOE) gaseous diffusion plants. (See Report 185 of January 1984 for an overview of DOE's enrichment plants.) Each cell is insulated to maintain a necessary operating temperature of 80 degrees Celsius. The cylindrical diffuser vessels of each stage are mounted on their vertical axes, and axial flow gas compressors are situated below each vessel (Figure 4). Cells can be disconnected from the cascade for maintenance; a massive sliding door seals each cell from a main service aisle during operation. Uranium hexafluoride (UF_6) feed and product lines between cells pass beneath the floor of the service aisle.

Building 1 is approximately 100 meters square and houses 14 small-sized cells having 0.6-MWe gas compressors for each stage. Building 2, approximately 150m by 220m, contains 20 medium-sized cells having 1.5-MWe compressors. Both building 3 and building 4 are approximately 250m by 200m, and each contains 18 large-sized cells having 3.3-MWe compressors. At full capacity, each *cell* in buildings 3 and 4 can produce 200,000 SWUs per year. Diffuser vessels tower as high as 18 meters.

Feed and Enriched Uranium Handling

An overhead walkway connects the process buildings to the control room and to the UF_6 feed and product buildings. The buildings in which UF_6 is handled are subject to Euratom and International Atomic Energy Agency (IAEA) safeguards inspection. Certificates of quantity and quality accompany all cylinders and sample containers having natural, enriched, and depleted UF_6.

Quantities of UF_6 are determined by weighing cylinders and containers before and after deliveries. (Generally one cylinder contains approximately 1,500 KgU as UF_6.) Quality (isotopic assay and percentage of impurities) is determined by laboratory analysis. Two samples per cylinder of feed are taken, one for plant analysis and one for reference in case of a dispute. Ordinarily three samples of enriched product are taken per group of six cylinders having the same product assay. If the purchaser requests, and at the purchaser's expense, three samples of tails (depleted UF_6) may be taken as well.

Ownership

Originally, five nations had shares in Eurodif through state-controlled nuclear fuel organizations. The French national company Cogema (Compagnie Generale des Matieres Nucleaires), which is the fuel arm of CEA (Commissariat a l'Energie Atomique), owned the largest independent share with 27.778 percent. A joint partnership of Cogema and the Atomic Energy Organization of Iran (AEOI), known as Sofidif (Societe Franco-Iranienne pour l'Enrichissement de l'Uranium par Diffusion Gazeuse), controlled 25.00 percent. The Italian government owned 25.00 percent through two entities having 12.50 percent each, Agip Nucleare and CNEN (Comitato Nazionale per L'Energia Nucleare). A Belgian company known as Soben (Societe Belge pour l'Enrichissement de l'Uranium) owned 11.111 percent, as did the Spanish fuel company Enusa (Empresa Nacional del Uranio S.A.).

As Table 6 indicates, the ownership of Eurodif has changed. Four nations rather than five now own interests in the company, and Cogema controls 61.528 percent, as a result of two events.

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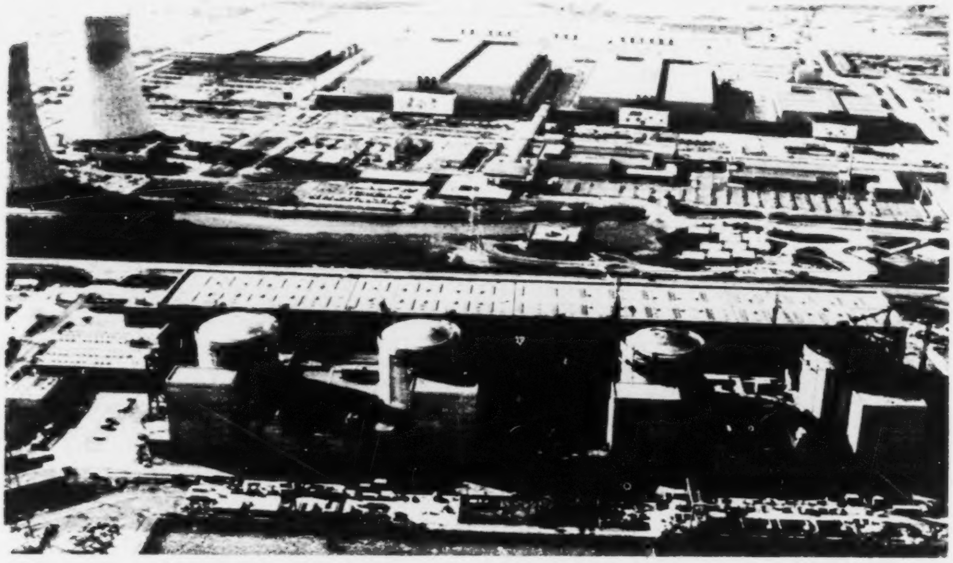

Figure 3. Eurodif plant site, showing four 900-MWe PWRs in foreground, cooling towers at left, and process buildings (one of which is not yet completed in this photo) in center background.

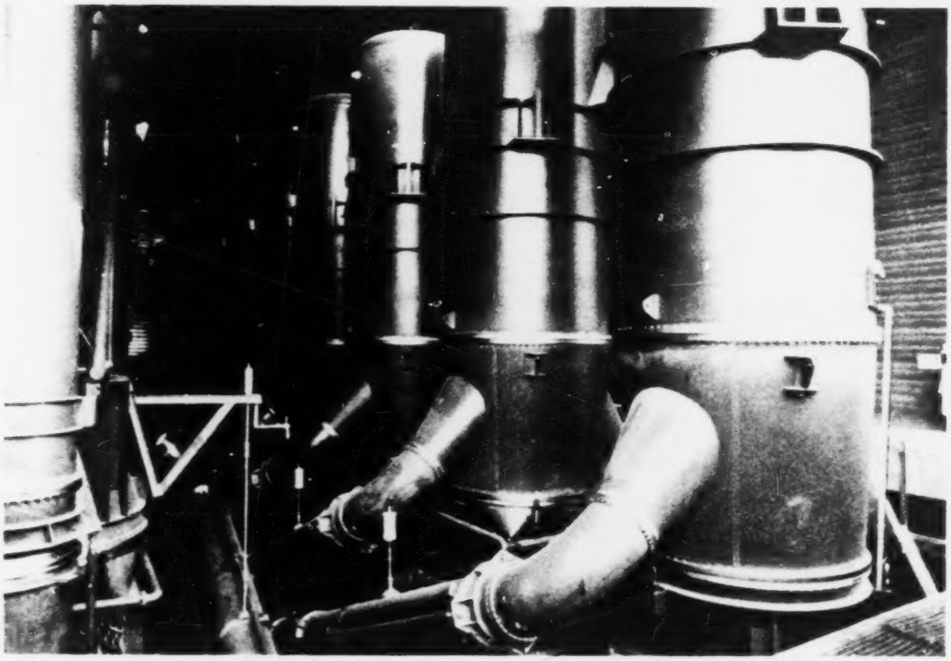

Figure 4. Small separation stages of a cell in the first process building.

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BASIC CONSIDERATIONS

1. Sofidif became a defunct organization following the revolutionary Iranian government's default on its commitment to Eurodif. Thus, Cogema owns all of the 25 percent formerly belonging to Sofidif.

2. The Italian partners sold to Cogema 8.75 percent of their cumulative share, reducing their participation from 25.00 percent to 16.25 percent (8.125 percent each). Agip Nucleare has since changed its name to Agip Uranio, and CNEN has been superseded by ENEA (Ente Nazionale per l'Energia Atomica) (which could be considered the equivalent of DOE plus the NRC in the USA).

The total cost for the enrichment plant was in the neighborhood of FF 23 billion ($4 billion at the time). Part of the financing for the plant came from an estimated $1 billion 1975 loan provided by the Iranian government of the last Shah. When the Islamic revolutionary government repudiated its commitment to take SWUs from Eurodif, CEA froze payments on the Iranian loan.

Table 6

EURODIF OWNERSHIP

Company	Country	Percent Share
Original Owners		
Cogema[1]	France	27.778
Sofidif[2]	France/Iran	25.000
Agip Nucleare	Italy	12.500
CNEN[3]	Italy	12.500
Enusa[4]	Spain	11.111
Soben[5]	Belgium	11.111
Current Owners		
Cogema[1]	France	61.528
Enusa[4]	Spain	11.111
Soben[5]	Belgium	11.111
Agip Uranio	Italy	8.125
ENEA[6]	Italy	8.125

[1] Cogema = Compagnie Generale des Matieres Nucleaires.

[2] Sofidif = Societe Franco-Iranienne pour l'Enrichissement de l'Uranium par Diffusion Gazeuse.

[3] CNEN = Comitato Nazionale per l'Energia Nucleare.

[4] Enusa = Empresa Nacional del Uranio S.A.

[5] Soben = Societe Belge pour l'Enrichissement de l'Uranium.

[6] ENEA = Ente Nazionale per l'Energia Atomica.

Current Overcapacity

At the time Eurodif was conceived over a decade ago, all of the member nations had ambitious nuclear power plans, and DOE's enrichment capacity appeared inadequate to satisfy future demand. Moreover, for Europeans greater autonomy of fuel supply (in this case enrichment services) was extremely attractive in light of their excessive dependence on imported oil. Based on then-prevalent growth projections, the Eurodif plant's SWU capacity would fulfill demand until the mid-1980s, when a new enrichment plant known as Coredif was to have begun providing supplementary capacity.

The years 1978–1982 altered Eurodif's situation dramatically. Contrary to earlier forecasts, electricity demand growth rates declined, and almost every Western nation experienced nuclear power plant delays and cancellations. (France was the one major exception.) In the USA alone, the decline in demand growth, aggravated by the Three Mile Island (TMI) incident in 1979 and by enormous plant construction cost overruns, caused the largest nuclear power program in the world to be cut virtually in half. The reduction of nuclear power programs affected Eurodif by reducing the demand for enrichment services. Adding to the emerging problem of enrichment oversupply, DOE in 1982 completed the phasing in of 10.1 million SWUs per year of additional capacity (through the Cascade Improvement Program and the Cascade Uprating Program). That was the year Eurodif reached full annual production capacity of 10.8 million SWUs.

Plant delays and cutbacks in Italy's and Spain's nuclear programs have led Enusa, Agip and ENEA to attempt to relieve some of their commitments to Eurodif over the past two years. (Termination charges for the Eurodif partners under their original contracts are estimated to be a prohibitive 80 percent of the contracted SWU price.) They have used two methods to achieve this result:

1. Electricity-for-SWU deals with Eurodif;
2. Secondary market SWU sales.

In an electricity-for-SWU deal, the shareholder pays Eurodif for the fixed portion of the committed SWUs (estimated to be 45 percent of the total cost) and imports from EDF the power which would have been necessary to generate them. Nuexco believes that the electricity-for-SWU contracts between Eurodif, EDF and the Italian and Spanish partners contain option provisions enabling the shareholders to take the SWUs if it best serves the partners' interests to do so (i.e., if secondary market sales of those SWUs are a better alternative).

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Eurodif has reduced its power requirement from EDF substantially over the past three years. Currently the enrichment plant operates at less than 60 percent of full capacity. The plant is EDF's largest single industrial customer. In 1981 it consumed 18.1 billion kilowatt-hours of electricity; in 1982 16.9 billion kwh; and in 1983 only 9.9 billion kwh. Eurodif's electricity demand reductions caused overall industrial electricity consumption in France to decline by 3.5 percent in 1983.

Production Commitments

EDF is Eurodif's biggest customer by far, having 28 nuclear units in commercial operation and 25 more under construction. Synatom of Belgium takes Soben's share of SWU deliveries to supply the enrichment requirements for Belgium's five operational units. Enusa supplies the requirements of Spain's six operating units; four other units are scheduled to begin commercial operation in Spain by 1990. All of the SWUs purchased by ENEA are in turn committed to the Italian state utility ENEL (Ente Nazionale per l'Energia Electrica), which operates two small reactors and one 900-MWe BWR. Japanese utilities have contracts to take approximately 1 million SWUs per year from Eurodif, and other European and Asian utilities purchase directly a smaller portion of the plant's output.

Presently Eurodif, like DOE and Urenco, is competing aggressively to expand its share of the primary enrichment market. Because Eurodif contracts are denominated in French francs and the franc is currently devalued relative to the US dollar, Eurodif prices appear competitively low. (The price was FF 971, or $115-120, in December 1983.) Plans for capacity expansion such as the Coredif plant have been shelved indefinitely as Eurodif seeks simply to bring its existing operation up to capacity.

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THE ROSSING PROJECT (PART 1)

Introduction

The Rossing uranium mine is the largest open pit uranium mine in the world, processing over 15 million tons of ore each year. It is located in the Namib Desert approximately 70 kilometers east of Swakopmund, Namibia (Figure 5). A subsidiary of Rio Tinto Zinc Ltd. (RTZ) of the United Kingdom defined the deposit in the late 1960s. In 1970, RTZ created a company known as Rossing Uranium Limited (RUL) to develop and operate a mine and mill. U_3O_8 production began in mid-1976. The mine has a remaining life of 15 to 20 years given the present production rate.

Uranium Discovery

Prospectors first discovered uranium near Rossing Mountain, in a remote part of the Namib Desert, in 1928. During the next 27 years sporadic prospecting throughout a concession area of 1,200 square miles resulted in the discovery of widely disseminated uranium-bearing rocks. Uranium mineralization was found to occur primarily in alaskite, a fine- to coarse-grained granitic rock found in association with a highly-folded metamorphic rock sequence.

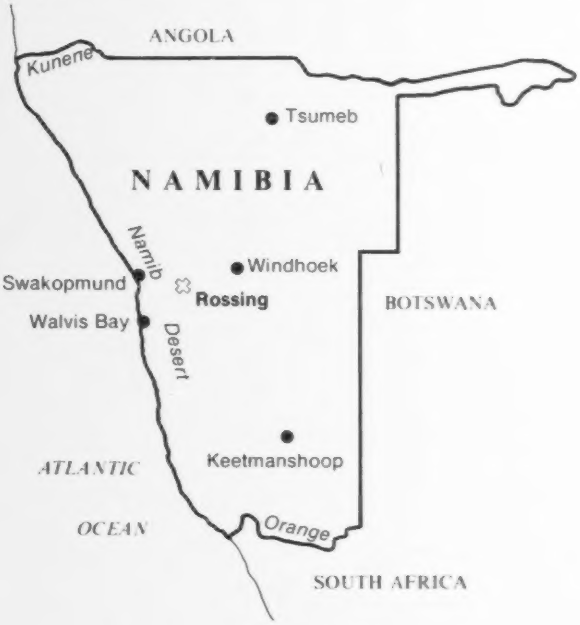

Figure 5
LOCATION OF ROSSING PROJECT

The first concerted action toward geologic assessment of the area came in 1955, when Anglo American Corporation secured a two-year option with the Louw syndicate, the property owner, to investigate the commercial potential of the concession. The company identified a number of radioactive anomalies, one of which it tested by diamond drilling and limited underground exploration work. During the evaluation process, geologists delineated highly disseminated mineralization averaging approximately 0.035 percent U_3O_8. However, no further action was taken and the two-year option period expired.

Commercial Development

In 1966 RTZ expressed an interest in the Namib property. RTZ had declined participation in development efforts on two previous occasions. Its renewed interest was attributable to two promising developments:

1. Emerging long-term uranium marketing opportunities;
2. Improvements in large-scale mining and mineral recovery technology.

RTZ assigned its South African subsidiary, Rio Tinto South Africa Ltd., to perform a cursory evaluation of the property. The result of that evaluation proved favorable. RTZ negotiated a six-year option with the Louw syndicate, and immediately thereafter dispatched a two-man team to begin detailed geologic studies of the concession area, which had been reduced to 400 square miles. As positive evaluation results accumulated, more technicians arrived to carry out radiometric surveys, geologic mapping, and percussion and diamond-core drilling. In 1970 the team sank a shaft on a favorable mineralized zone to obtain a large-volume ore sample for metallurgical test work. The ore sample was processed in a newly constructed pilot plant. Laboratory recovery results were confirmed, and design work proceeded on a commercial-sized recovery plant. Some 90 employees were on site at that time.

Also in 1970, RTZ created a subsidiary company known as Rossing Uranium Limited (RUL) to operate the project. RUL completed orebody evaluation in May 1973. Coincidental with the last phase of evaluation activity, RTZ negotiated sales of future U_3O_8 production and arranged project financing. The corporate decision to proceed with project development came in August 1973.

Open-pit mining and construction of a processing plant began in mid-1974. The mill started operating in March 1976 and produced the first U_3O_8 three months later. A series of start-up problems, including a fire that de-

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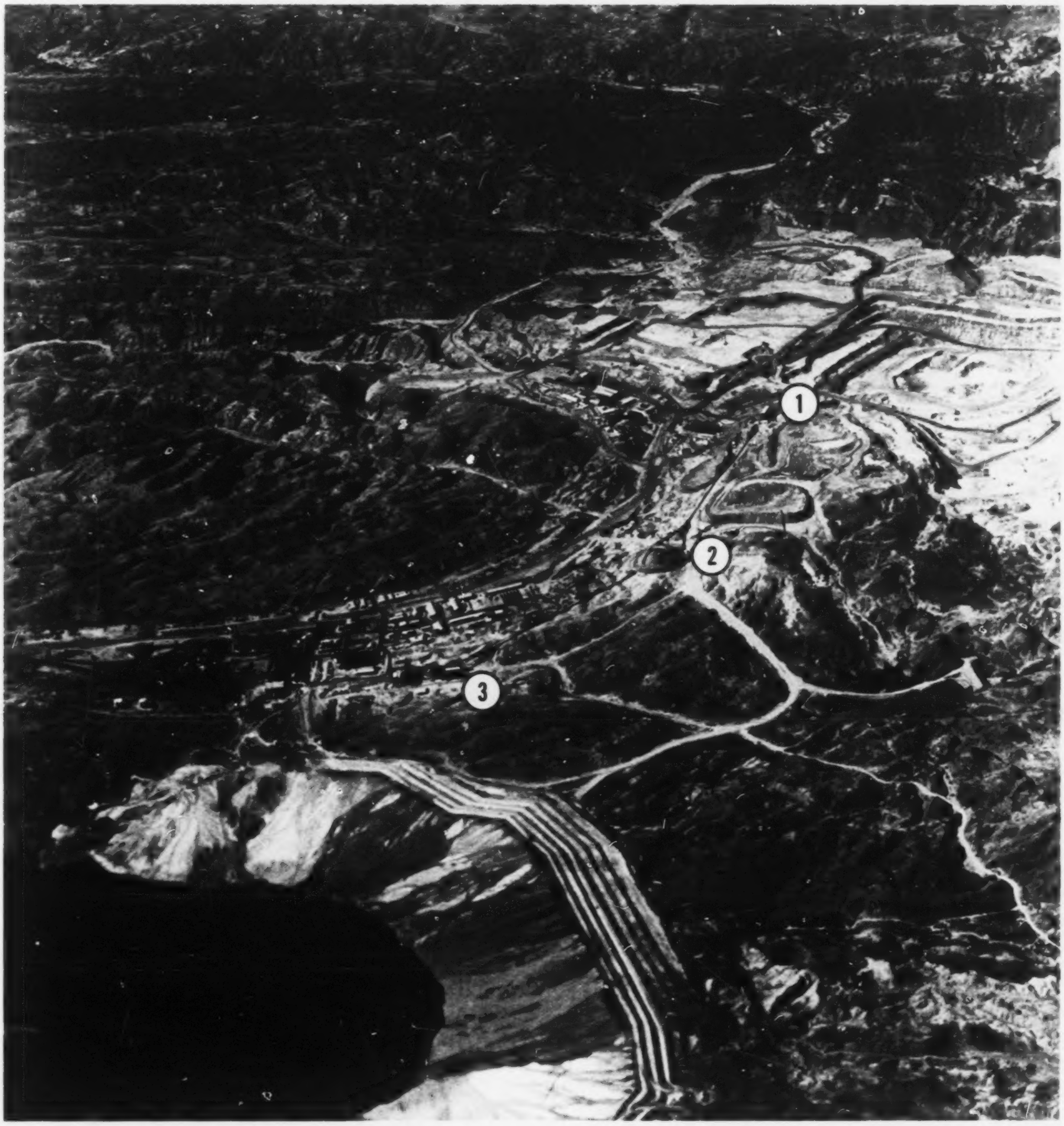

Figure 6. Aerial view of Rossing Project, Namibia. Open pit is at right center, mill and tailings dam lower left of photo. Note ore conveyor delivery system from mine to mill. Mined ore is crushed (1) and delivered by conveyor to stockpile (2) for secondary crushing and delivery by conveyor to the mill (3).

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stroyed part of the solvent extraction unit, and subsequent design modifications delayed the original production schedule. However, by 1979 annual production had reached approximately 10 million pounds U_3O_8, the largest production rate of any operating uranium mine in the world. Annual production has continued since at that level. (Figure 6 shows an aerial view of the project.)

RTZ sold shares of RUL to a diverse group of mining and investment companies in the mid-1970s (Table 7). Having a net beneficial interest of 46.5 percent, RTZ controls the largest share of the company. Industrial Development Corporation of South Africa controls 13.5 percent. Minatome of France originally held a 10-percent interest; title of that share shifted to Total Compagnie Miniere when Total took over Minatome in 1982. Rio Algom Ltd. of Canada also has 10 percent. Urangesellschaft GMBH of the Federal Republic of Germany holds 5 percent, and General Mining Corporation of South Africa has 2.3 percent. The remaining 17.85 percent is held by several companies and/or national entities that participate under strict provisions of secrecy. Their names have not been revealed publicly by RUL.

Table 7

OWNERSHIP OF ROSSING URANIUM LTD.

Company	Country	Percent Share
Rio Tinto Zinc Group PLC[1] [2]	UK	41.35
Industrial Development Corp.	South Africa	13.5
Total Compagnie Miniere	France	10.0
Rio Algom Ltd.[1]	Canada	10.0
Urangesellschaft GMBH	FRG	5.0
General Mining Corporation	South Africa	2.3
Other	—	17.85

[1] RTZ owns 51.3% of Rio Algom, so RTZ's net beneficial interest in Rossing is 46.5%.

[2] RTZ is now Rio Tinto Zinc Group PLC.

Exploration and Surface Evaluation

Rio Tinto South Africa introduced a multi-functional geophysical program in the early stages of exploration. Airborne radiometric and magnetic surveys were conducted over a large part of the general concession area. Ground surveys followed on zones of known mineralization and on newly discovered anomalies. Ground radiometrics eventually were concentrated in a 75-square-mile area, determined as the primary area of interest. The approximate outline of the Rossing deposit was eventually established within an area of approximately two square miles as a result of detailed radiometrics, geologic mapping and rock sampling.

Rio Tinto initiated percussion drilling on the deposit site to determine the distribution of uranium. Overall, 250 holes were drilled at an incline of -45 degrees on a north-south-oriented grid pattern. The holes averaged 120 feet in drilled depth for an accumulated total of 30,000 feet. Drilling confirmed an even distribution of uranium mineralization across the surface formations.

The next period of project evaluation entailed deeper drilling. Rio Tinto completed over 182,000 feet of coring in two phases during the period May 1967-June 1971. All but two holes were drilled on an incline of -45 degrees to the north for better penetration of the steeply dipping rock formations. During the first phase, the holes were drilled to a depth of 400 to 1,000 feet, depending on topography and rock characteristics. Spacing followed 400-foot centers along north-south grid lines. The second phase of holes, some drilled as deep as 1,800 feet, also followed 400-foot spacing within the same grid system and thus reduced hole spacing to 200 feet. Two holes located near the central portion of the ore deposit were drilled to a vertical depth of 1,500 feet, which was then considered the approximate depth limitation of minable ore.

Underground Evaluation

Underground bulk sampling made a major contribution to ore deposit evaluation. A 375-foot vertical shaft strategically located on the deposit provided access to the ore. Main drifts were driven east and west from the shaft bottom to the outer limits of the ore. Next, crosscut drifts were driven north and south off the mains, paralleling the surface drill sections. The crosscuts intersected a number of drill holes. Horizontal long-hole drilling preceded drift advance, enabling pre-classification of rock type and ore values in relation to waste rock. Over 9,000 feet of underground development drifting had been completed by December 1971.

The underground program allowed close coordination with the surface drilling results. The combined results provided useful geologic information regarding structural and stratigraphic features, distribution of uranium mineralization, and ratio of ore to waste. Final distribution and grade of mineralization were accurately estimated through radiometric and chemical analysis of carefully selected and prepared core samples and underground bulk samples. An official ore reserve estimate has not been issued for the deposit. However, Nuexco has reported reasonably assured resources of 100,000 tons U_3O_8 at an average grade of 0.035 percent (see World Uranium Resources, Nuexco Special Report, November 1980).

Part 2 of the article on the Rossing Project will focus on project development and the geology of the deposit.

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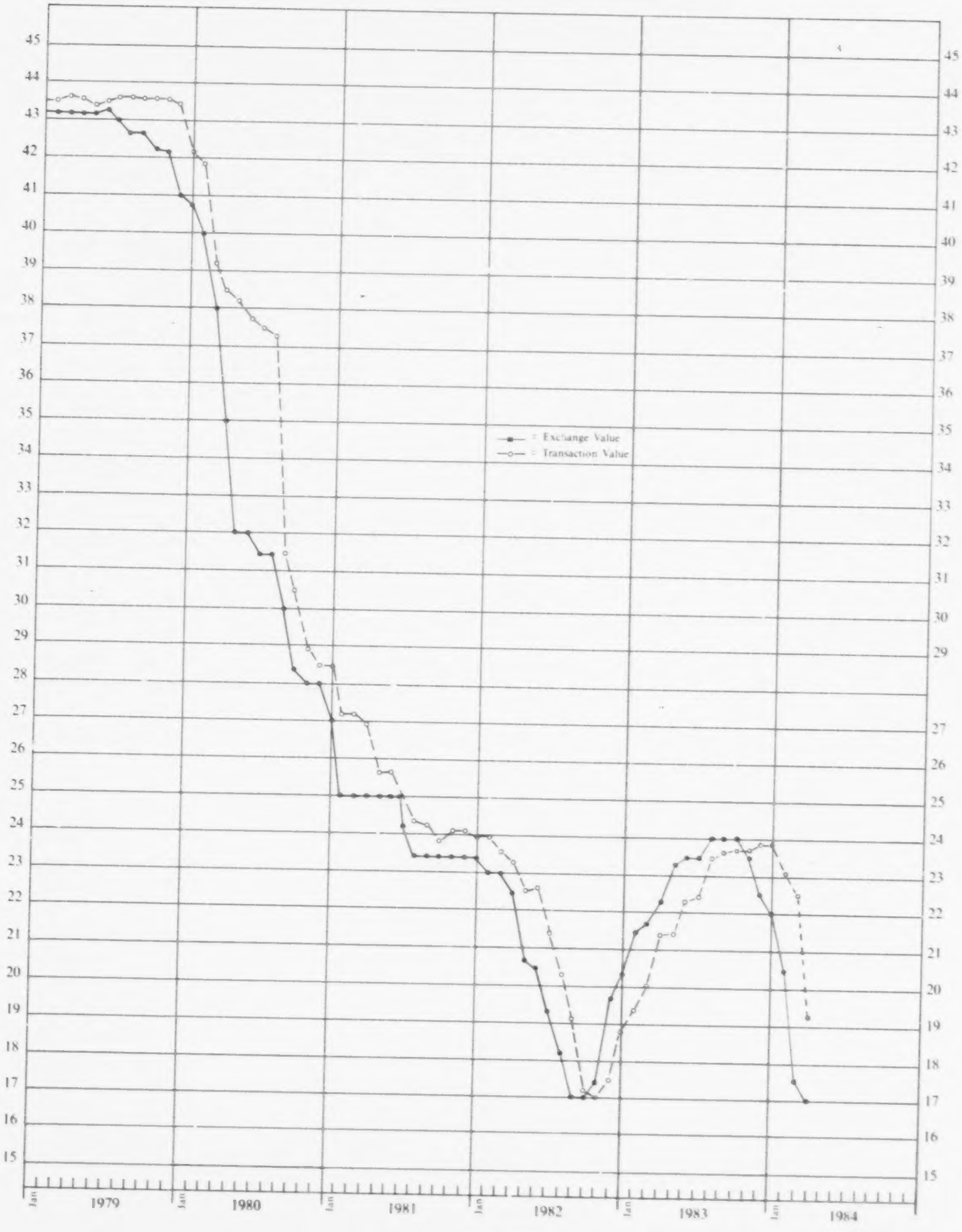
HISTORICAL MARKET DATA

EXCHANGE AND TRANSACTION VALUES
SINCE JANUARY 1979

Determined as of the last day of the month indicated



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HISTORICAL MARKET DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	32.50	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00
1984	20.50	17.50	**17.00**									

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85
1984	23.05	22.50	**19.25**									

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60
1984	0.60	0.30	**0.80**									

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AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage Earners, Weekly Rates[2] (1976=100)
1972 Avg.	105.6	71.3
1973 Avg.	124.4	79.0
1974 Avg.	141.9	108.1
1975 Avg.	150.4	132.6
1976 Avg.	168.4	160.9
1977 Avg.	192.0	179.0
1978 Avg.[3] [4]	198.5	190.0
1979 Avg.	248.8	127.9
1980 Avg.	321.8	140.8
1981 Avg.	355.3	154.1
1982 Avg.[5]	368.6	174.9
1983 Avg.	—	181.8R
Jan 1983	385.7	179.6
Feb 1983	387.5	179.8
Mar 1983	397.4	179.7
Apr 1983	407.3	180.0
May 1983	414.8	180.1
Jun 1983	415.6	180.2
Jul 1983	408.4	179.9
Aug 1983	403.1	179.9R
Sep 1983	403.1	179.8R
Oct 1983	397.6	187.6R
Nov 1983	395.3P	187.6R
Dec 1983	—	187.4R
Jan 1984	—	187.6P

P = Preliminary R = Revised since last month

[1] Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0).

[2] Australian Bureau of Statistics, Canberra: "Award Rates of Pay Indexes, Australia" (Catalogue No. 6312.0). Figures for the latest fourteen months shown are subject to revision.

[3] Monthly data for 1970-78 appear on pages 4.7 and 4.8 of Report 138.

[4] Annual averages prior to 1979 reflect index base no longer in use.

[5] Monthly data for 1979-82 appear on page 35 of Report 184.

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GOVERNMENT STATISTICS

CANADA

	Industry Selling Price Index: Manufacturing[1] (1971=100)	Wage-earner Data: Average Hourly Earnings (C$)[2]						
		Uranium Mines (SIC 057)	Metal Mines (SIC 051-059)	Mines, Quarries and Oil Wells[3] (SIC 051-099)	Primary Metal Industries Non-ferrous[4]			Chemicals and Chemical Products[5] (SIC 370-379)
					(SIC 296)	(SIC 296-298)	(SIC 298)	
1979 Avg.[6]	217.9	—	9.60	9.66	—	7.35	—	7.67
1980 Avg.	247.2	—	10.59	10.80	—	8.05	—	8.50
1981 Avg.	288.7	—	12.02	12.23	—	9.03	—	9.53
1982 Avg.[7]	288.8	—	13.74	13.92	—	9.98	—	10.63
1983 Avg.	298.8R	—	14.68R	14.40R	—	—	—	11.28R
Jan 1983	292.7	—	14.36	14.35	—	10.72	—	11.06
Feb 1983	293.5	—	14.24	14.28	—	10.74	—	11.06
Mar 1983[8]	295.2	16.79	14.84	14.48	—	10.93	—	11.21
Apr 1983	297.1	16.83	14.40	14.13	11.57	—	10.10	11.02
May 1983	298.5	17.02	14.50	14.10	11.39	—	9.82	10.97
Jun 1983	299.3	17.02	14.60	14.07	11.33	—	9.84	11.05
Jul 1983	300.4	16.48	14.35	13.93	11.70	—	9.83	11.04
Aug 1983	301.3R	16.93	14.36	13.89	11.82	—	10.08	11.19
Sep 1983	301.1R	17.66	14.90	14.41	11.99	—	10.32R	11.29
Oct 1983	301.6R	17.73	15.27	14.65	11.76	—	10.03	11.30
Nov 1983	301.7	17.85R	15.24R	15.31R	12.43R	—	11.39R	12.00R
Dec 1983	302.7R	17.88	15.10R	15.23R	12.69R	—	11.33R	12.12R
Jan 1984	304.9R	—	—	—	—	—	—	—
Feb 1984	306.3P	—	—	—	—	—	—	—

P = Preliminary R = Revised since last month

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[1] Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (Catalogue 62-011). Indexes for the most recent six months shown are subject to revision.

[2] Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours" (Catalogue 72-002).

[3] Reports 175 through 185 list this series title incorrectly as "Metal Mining, Including Milling (SIC 050-099)".

[4] Beginning with the April 1983 figure, Primary Metal Industries, non-ferrous is split into SIC 296 and SIC 298.

[5] Chemical and Chemical Products prior to April 1983 was SIC 370-379. The new series is from a new survey which includes all companies and is based on a 1970 classification. The old survey only included companies of 20 employees or more.

[6] Monthly ISPI for 1977 and 1978 appear on page 4.10 of Report 138, and monthly wage-earner data for 1973-78 appear on page 4.11 of Report 138.

[7] Monthly data for 1979-1982 appear on page 37 of Report 184. On that page, the wage earner index entitled "Metal Mining, Including Milling (SIC 050-099)" should read Total Mining (SIC 051-099)".

[8] Beginning with the April 1983 figure, Wage Earner Data are based on a census of all companies employing 200 or more wage earners, *plus* a random survey of companies employing fewer than 200 wage earners. Prior to April 1983 only companies employing fewer than 200 wage earners are included in the Wage Earner Data.

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REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100)[3]	Producer Price Index All Groups[4] (1975=100)	Total Employment in Mining and Quarrying (Code 35)[5]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[5]
1972 Avg.	8.79	113.3	63.9	623,067	443,933
1973 Avg.	10.51	124.1	72.3	684,743	572,133
1974 Avg.	13.18	138.5	85.3	674,140	761,596
1975 Avg.	16.71	157.2	100.0	639,473	1,003,617
1976 Avg.	19.30	174.7	115.1	671,240	1,212,983
1977 Avg.	23.87	194.4	130.0	712,006	1,420,670
1978 Avg.	27.14	137.2	142.7	664,571	1,537,169
1979 Avg.[6]	30.18	155.3	164.5	692,209	1,830,632
1980 Avg.[7]	35.53	176.7	192.1	714,379	2,279,615
1981 Avg.	41.89	206.5	218.3	728,506	2,820,505
1982 Avg.[8]	47.25	233.5	248.7	707,552	3,246,071
1983 Avg.	51.87	262.2	274.8	696,579	3,644,772
Jan 1983	—	249.0	264.9	688,030	289,075
Feb 1983	—	253.1	267.4	697,089	281,413
Mar 1983	50.35	255.9	269.1	695,976	290,586
Apr 1983	—	257.8	270.9	697,158	286,708
May 1983	—	259.7	274.1	701,712	295,701
Jun 1983	50.51	260.8	273.1	706,933	300,177
Jul 1983	—	262.5	273.7	704,202	314,566
Aug 1983	—	265.6	278.9	698,984	311,789
Sep 1983	52.92	267.3	279.4	696,435	312,264
Oct 1983	—	270.0	281.0	693,225	311,418
Nov 1983	—	271.4	281.6	688,459	317,485
Dec 1983	53.70	273.2	283.7	690,750	333,595
Jan 1984	—	274.7	283.3	—	—
Feb 1984	—	278.4	—	—	—

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[1] Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly. The tonnage-weight index of average working costs per metric ton of gold ore milled for 1983 follows. (Base: March quarter 1982 = 100). See page 16 of Report 178 for the description and calculation of index, and page 24 of Report 178 for figures for 1982.

1983:	January-March	111.2
	April-June	111.9
	July-September	117.4
	October-December	119.6

[2] Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."

[3] For annual averages prior to 1978, April 1970 = 100.

[4] Previously known as the Wholesale Price Index, now the Producer Price Index. The computation remains the same.

[5] Bulletin of Statistics, Department of Statistics, Pretoria.

[6] Historical data for the Average Declared Working Costs and Consumer Price Index 1970-1979 appear on page 4.9 of Report 140.

[7] Monthly data for Codes 35 and 40, 1977-1980, appear on page 28 of Report 157.

[8] Monthly data for 1979-82 appear on page 39 of Report 184.

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GOVERNMENT STATISTICS

UNITED STATES

	Producer Price Index[1]		Consumer Price Index[2]	GNP Implicit Price Deflator[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
	Industrial Commodities (1967=100)	All Commodities (1967=100)	(1967=100)	(1972=100)	Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1972 Avg.	117.9	119.1	125.3	100.00	4.56	4.59	4.26	3.71
1973 Avg.	125.9	134.7	133.1	105.75	4.84	4.98	4.51	3.91
1974 Avg.	153.8	160.1	147.7	115.08	5.44	5.63	4.88	4.21
1975 Avg.	171.5	174.9	161.2	125.79	6.13	6.24	5.39	4.64
1976 Avg.	182.4	183.0	170.5	132.34	6.76	6.87	5.91	4.96
1977 Avg.	195.1	194.2	181.5	140.05	7.28	7.67	6.43	5.39
1978 Avg.[5]	209.4	209.3	195.4	150.42	8.23	8.56	7.02	5.82
1979 Avg.	236.5	235.6	217.4	163.42	9.27	9.50	7.60	6.32
1980 Avg.	274.8	268.8	246.8	178.64	10.26	10.63	8.30	6.94
1981 Avg.	304.1	293.4	272.4	195.51	11.55	11.98	9.12	7.62
1982 Avg.[6]	312.3	299.3	289.1	207.15	12.33	12.94	9.96	8.21
1983 Avg.	315.8	303.1	298.4	215.63R	12.67	13.44	10.58	8.66
Jan 1983	313.9	299.9	293.1	—	12.63	13.33	10.34	8.53
Feb 1983	313.9	300.9	293.2	—	12.66	13.29	10.41	8.56
Mar 1983	313.5	300.6	293.4	212.83	12.48	13.35	10.39	8.60
Apr 1983	312.4	300.6	295.5	—	12.67	13.34	10.43	8.60
May 1983	313.6	301.5	297.1	—	12.55	13.62	10.50	8.60
Jun 1983	315.3	302.4	298.1	214.55	12.66	13.38	10.52	8.63
Jul 1983	316.5	303.2	299.3	—	12.68	13.56	10.58	8.69
Aug 1983	317.3	304.7	300.3	—	12.63	13.46	10.61	8.64
Sep 1983	317.1	305.3	301.8	216.44	12.71	13.47	10.69	8.75
Oct 1983	318.5R	306.0R	302.6	—	12.78	13.56	10.78	8.73
Nov 1983	318.3	305.6	303.1	—	12.72	13.56	10.86	8.78
Dec 1983	318.4	306.0	303.5	218.53R	12.85	13.34R	10.89	8.86R
Jan 1984	319.2	308.1	305.2	—	12.79	13.38	10.89R	8.90R
Feb 1984	320.4	308.8	306.6	—	—	—	10.89	8.88

P = Preliminary R = Revised since last month

[1] US Bureau of Labor Statistics, Washington, D.C.: "Producer Prices and Price Indexes," (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

[2] US Bureau of Labor Statistics, Washington, D.C.: Consumer Price Index for All Urban Consumers, US City Average, All Items.

[3] US Department of Commerce, Washington, D.C.: Bureau of Economic Analysis, National Income and Wealth Division: "Survey of Current Business." The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

[4] US Bureau of Labor Statistics, Washington, D.C.: "Employment and Earnings." 2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for 1977-1978 are adjusted to the March 1979 benchmark. Data for January 1979 and beyond are adjusted to the March 1980 benchmark.

[5] Monthly data 1970-1978 for Producer Price Index-Industrial Commodities, Consumer Price Index, and Employment and Earnings SIC codes 10, 333, and 28, and quarterly data for GNP Implicit Price Deflator appear on pages 4.6-4.8 of Report 139.
Monthly data 1977-1978 for Employment and Earnings SIC Codes 10, 333, and 28 appear on page 33 of Report 147.
Monthly data 1970-1978 for Employment and Earnings SIC Code 36 appear on page 23 of Report 154.
Monthly data 1977-1980 for Producer Price Index-All Commodities, appear on page 21 of Nuexco Report 158.

[6] Monthly data 1979-1982 for all listed indices appear on page 41 of Report 184.

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SOUTH AFRICA'S ROLE IN THE URANIUM MARKET

By

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Presented at
Nuexco's Luncheon
during the

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Atlanta, Georgia
April 2, 1984

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SOUTH AFRICA'S ROLE IN THE URANIUM MARKET

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Introduction

It is a pleasure to be in the United States again, and a privilege to address an audience so prominent in the uranium and nuclear power business.

By way of introduction, I thought I would give you a few facts about my country, the Republic of South Africa. I will then tell you about the history, economics and structure of the South African gold and uranium mining industry, and, finally, I will discuss the marketing of and market for South African uranium.

South Africa

Situated at the southern tip of Africa, South Africa is about one-eighth the size of the USA and two-thirds the size of the EEC. It has a multi-national population of 25.5 million, of whom 17.2 million are Blacks coming from ten separate ethnic groups. The predominant business language is English. There are four main Black language groups and twenty-three sub-groups.

South Africa is endowed with substantial natural resources, having the largest reserves in the free world of gold, platinum-group metals, manganese ore, vanadium, chrome ore, fluourspar and gem diamonds, and is the world's largest exporter of most of these minerals. It is one of the world's largest exporters of steam coal, the second largest exporter of uranium, and it is 50 percent self-sufficient in oil produced from coal in SASOL's liquifaction plants.

The South African economy is a modern industrial one based on manufacturing, mining and agriculture, with a gross domestic product in 1983 of approximately 80 billion Rands (approximately US $79 billion). Total foreign investments in South Africa exceed $30 billion and have been growing at 14 percent per annum. There are 375 US companies invested in South Africa and the value of direct and indirect US investment is approximately $5 billion. South Africa's international investment risk rating currently is reported to be its most favorable ever at about tenth position. With regard to foreign trade, South Africa ranks in the world's twenty largest trading nations, and in 1983 the total value of foreign trade was $32 billion. In 1982, the USA became South Africa's largest trading partner, with total trade between our two countries valued at just over $4 billion, followed by the United Kingdom, the Federal Republic of Germany and Japan. South Africa is one of the world's seven major food exporting countries. Our national economic policies support free enterprise and stress reliability as a trading partner.

As regards infrastructure, South Africa has 23,000 kilometers of railways, our national airline has 35 regular flights to 26 countries a week, and 18 foreign airlines operate regular services to South Africa. The country has some of the continent's largest natural harbors, through which the bulk of our exporting takes place. South Africa has direct telephone dialing to 41 countries. Our national electric utility, Escom, supplies approximately 94 percent of the country's electricity from its installed capacity of approximately 24,000 MWe, and has a further 20,000 MWe of capacity currently planned or under construction. Ninety percent of Escom's electricity is coal-based, the balance being uranium and hydro.

Politically, two important events have taken place in our country in the last six months. First, South Africa has adopted a new constitution, in place of our inherited Westminster system, that absorbs Coloureds and Asians (14 percent of the populace) into the political structure formerly controlled only by Whites (18 percent of the populace). Second, Prime Minister P. W. Botha in March signed the Nkomati Accord with President Samora Machel of Mozambique. The pact is the second non-aggression treaty entered into with a neighboring country in the past two years.

The Nkomati Accord, calling for the renunciation of the use of force by both parties and prohibiting the support of insurgents hostile to either government, could mark the end of a decade of growing enmity between the two neighbors. Together with the withdrawal of South African troops from Angola following the negotiation of a joint South African–Angolan disengagement agreement, the treaty has been applauded internationally and appears to have the support of the other Black African states in the sub-continent. Both these events are seen by many as steps in the right direction, and seem to have established a significant momentum towards the abolition of racial discrimination, towards peaceful coexistence with our neighbors, and especially towards the resolution of South Africa's thorniest external problem: the achievement of a political settlement in Namibia.

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These events have enhanced substantially the prospects for stability and prosperity in the Southern African subcontinent.

History and Economics

Gold was discovered on the Witwatersrand in 1886. Since then, it has taken 26 million man-years of labor applied over nearly a century to mine, mill and deposit on-surface almost 4 billion tons of gold-bearing ores in the process of producing more than 38,000 metric tons (1.2 billion ounces) of gold, and, since uranium production started in 1952, nearly 300 million pounds U_3O_8. Gold mining started on the surface outcrops and has now reached depths of 12,000 feet, with plans to mine to 15,000 feet.

Although the association of uranium with the Witwatersrand ores has been known since 1923, it was the joint British-American search for uranium for the Manhattan Project that resulted in the re-testing of South African ores and the establishment of large quantities of uranium in the late 1940s. In 1952 the first uranium plant opened at West Rand Consolidated Mines. By 1959, there were 26 mines with 17 uranium plants, producing 13 million pounds U_3O_8—all committed to the Combined Development Agency (CDA). Between 1959 and 1965, the demand for uranium for nuclear weapons declined dramatically, resulting in cutbacks so that by 1965, South African uranium production had fallen to 5.5 million pounds U_3O_8 from eight mines. The 1970s saw the industry respond to the recovery in the uranium market with large expansions, and by 1981, production had peaked at 15.8 million pounds U_3O_8.

Production in 1983 was 15.7 million pounds U_3O_8, representing approximately one-sixth of free world output. This was produced by 14 mines from 17 plants which treated approximately 75 million tons at an average grade of under 1/3 pound per ton treated. This grade is so low because it includes three large tailings treatment operations which processed about 45 million tons in the year at an average grade of less than 0.20 pounds U_3O_8 per ton treated, which accounted for one-fifth of total national production. Excluding such surface tailings operations, the industry's average grade was 0.37 pounds U_3O_8 per ton treated for the year.

All South African producers, except three, are gold by-product producers. Two of these exceptions are primary producers; namely, the Beisa and Harmony Mines, and one, Palabora, produces uranium as a by-product from copper production. Palabora produces nearly 500,000 pounds U_3O_8 per annum, representing 3 percent of South Africa's total production. Vaal Reefs is by far the largest single by-product producer with an output of approximately 4 million pounds U_3O_8 per annum, which represents 26 percent of South Africa's total output. This large facility mines and mills 9.5 million tons of ore a year to produce 80 tons of gold, and in the process, puts 32,000 men underground, to an average depth of more than 6,000 feet each day.

The viability of the South African gold and uranium industry can be illustrated by reference to the change in certain economic indicators over the ten-year period from 1973 to 1982 (Table 1).

Table 1

SOUTH AFRICAN ECONOMIC INDICATORS

Economic Indicator	1973	1982	Percent Change
Average working cost per ton ore milled	R10.51	R47.25	+35
Average declared recovery grade, grams per ton	11.2	6.4	-43
Average declared uranium grade treated, pound/ton	0.53	0.35	-34
Average declared working profit per ton milled	R13.42	R45.45	+238
Average London gold price, per ounce	$97.20	$375.89	+287
Average gold receipts, per ounce	R65.08	R412.41	+534
US Dollar/Rand Exchange Rate	1.49	0.91	-39

From Table 1 it is evident that, despite a substantial increase in working cost, and a decline in average grade, working profit expressed in Rands increased substantially due to the increase in the gold price and the strengthening of the US dollar relative to the Rand. This latter phenomenon acted as a cushion to falling gold and uranium prices, as prices for all South Africa's gold and most of its uranium are denominated in US dollars.

Industry Structure

The South African gold and uranium industry is con-

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trolled and administered by six mining financial groups, known as mining houses: Anglo-American Corporation, General Mining Union Corporation, Gold Fields of South Africa, Rand Mines, Johannesburg Consolidated Investment company, and Anglovaal. The mining houses are represented by an organization known as the Chamber of Mines, which provides certain services common to the industry, such as labor recruitment, wage negotiations, safety control, research and marketing. For the purpose of uranium marketing, the Chamber has a subsidiary known as the Nuclear Fuel Corporation of South Africa (Nufcor). Nufcor is a centralized uranium marketing organization, through which all of South Africa's uranium is sold, except for that of Palabora, which is independent of the Chamber.

Nufcor also processes the ammonium diuranate (ADU) slurry from all the Chamber producers at a central filtration and calcining plant. The natural uranium concentrates are then sampled, packed and shipped to Nufcor's various customers. The Nufcor product is known to be one of the most homogenized available worldwide.

Nufcor is one of the largest suppliers of uranium in the free world, having supplied, since its inception in 1952, approximately 270 million pounds U_3O_8, equivalent to about 15 percent of free world consumption since that date. This has been achieved without a single contract default. It has been able to provide this impeccable security of supply by virtue of its spread of low-cost supply sources. Furthermore, because of its unique structure and by-product supply sources, it has the flexibility to vary production to meet market circumstances relatively quickly.

The South African uranium industry operates under the legal framework of the Atomic Energy Act of 1967. This Act is administered by a government body, the Atomic Energy Corporation (AEC). All uranium contracts require AEC approval, and exports are controlled by the issue of export permits. AEC policy fully recognizes private enterprise, and the commercial aspects of uranium business are left largely to the industry. Its controls are directed to issues of national policy, such as ensuring peaceful usage of uranium and the adherence to international safeguards requirements. The Atomic Energy Act contains certain requirements of confidentiality in respect of uranium matters, the roots of which go back to the days of procurement by the Combined Development Agency.

Marketing

As the marketing arm of the Chamber of Mines producers, Nufcor advises its members on the uranium market and marketing. However, it has little control over individual producers' production levels. Producers' needs and motivations can and do differ, depending on their individual circumstances, such as cost structure, contract positions and stockpiles. Nufcor endeavors to meet the needs of all its members while at the same time maintaining maximum effectiveness in the market. These objectives understandably are difficult to achieve sometimes, especially in a buyer's market, when individual producers' needs tend to differ more than in a seller's market.

Nufcor's traditional modus operandi is to allocate the contracts it negotiates on a shared basis under which producers elect to participate or not. Under this system, Nufcor calls for price and quantity specifications from producers in advance. It then contracts and allocates among those whose criteria are met. Notwithstanding this system, Nufcor does act as the agent in contracts entered into directly between producers and consumers, if producers so desire. However, the allocation system is more prevalent, especially in difficult market conditions.

South Africa has traditionally contracted on a long-term basis with strong emphasis on creating lasting relationships with customers, often with consumer finance arrangements, and with annual price negotiations. Nufcor's current activity has been centered around preserving its existing contract positions, South African producers in general having elected to stockpile surplus production rather than sell in the spot market. A few higher-cost producers have shut down production, West Rand Consolidated, a primary producer, having been the first to do so in 1982. Harmony, another primary producer, recently announced its intention to close its Merriespruit plant, which will result in a 28-percent decrease in output. More recently, Western Deep Levels announced the possibility of its terminating uranium production and converting its plant to a gold plant. These producers have stockpiles or back-up arrangements to meet contract commitments.

Given the current high interest rate structure in South Africa, the possibility of a weaker US Dollar/Rand exchange rate and little prospect of substantially higher uranium prices in the short to medium-term, the need of the few higher cost gold and uranium producers with uncommitted supplies to enter the spot market should be greater than those of the richer mines. However, in conflict with this need is the industry's concern that entering the spot

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market could have a "negative feedback effect" on annual contract price renegotiations. To date, this concern has tended to outweigh the desire to contract in the spot market.

Markets for South African Uranium

The majority of South Africa's uranium has been sold under long-term contracts to Europe and the Far East. Nuexco estimates the distribution of South Africa's customers in 1984 to be as indicated in Table 2.

Table 2

ESTIMATED DISTRIBUTION OF 1984 SOUTH AFRICAN PRODUCTION COMMITMENTS

	Pounds U_3O_8 (millions)	Percent of Total
Europe	6.2	43.6
Far East	3.6	25.4
U.S.A.	3.0	21.0
Other[1]	1.4	10.0
TOTAL	14.2	100.0

[1] Includes supplies to Koeberg units 1 and 2, Escom's nuclear power station (two 922-MWe PWRs).

Nuexco's estimate of South Africa's uncommitted production to 1992 (excluding existing inventories) is listed in Table 3, and Nuexco's estimate of unfilled requirements in the USA (including producers) for the same period is shown in Table 4.

In comparing South Africa's uncommitted production with US unfilled requirements, it is evident that both countries' uranium positions are complementary; that each needs the other, and that they should be brought together by market forces. However, for this to occur, certain perceptions and market behavior will need to change. Consequently, I have attempted to identify certain forces that exist as well as conditions that are necessary for such a meeting of the ways between our two countries in the uranium market.

1. South Africa's existing markets are fast becoming fully supplied, and traditional customer countries have far longer-term inventory positions than has the USA. South African producers will soon have to face the decision of whether to sell in the USA, where the majority of new business lies, at lower spot-related prices. The alternatives are:

a. to stockpile;
b. to shut down high-cost facilities;
c. to sell.

At the March 31 Exchange Value of $17 per pound U_3O_8, the third alternative requires penetrating the psychological barrier of having to sell at one of the lowest-ever real uranium prices available to the industry.

In general, it could be predicted that South African producers will become more individualistic as they are forced to adapt to meet their own particular circumstances. The US market awaits those that elect to continue to produce and sell uranium.

2. The USA is fast becoming a large importer of uranium as its own high cost production is going out of business. US production fell from 26.8 million pounds U_3O_8 in 1982 to 20.6 million pounds in 1983, and is estimated by Nuexco to decline to second world position alongside South Africa at about 15 to 16 million pounds in 1984, as Canada assumes the lead. The USA imported 12.3 million pounds U_3O_8 in 1983 and, taking account of exports in that year, was a net importer of 6.3 million

Table 3

SOUTH AFRICAN UNCOMMITTED PRODUCTION (Millions of Pounds U_3O_8)

	1984	1985	1986	1987	1988	1989	1990	1991	1992
South Africa	1.6	2.5	5.5	7.1	8.1	9.5	9.5	10.4	11.8
Free World Total	6.7	11.6	20.7	22.7	30.3	34.1	38.8	51.1	58.2
Percent of Free World Total	24	22	27	26	27	28	24	20	20

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Table 4

US UNFILLED REQUIREMENTS
(Millions of Pounds U_3O_8)

	1984	1985	1986	1987	1988	1989	1990	1991	1992
U.S.A.	1.8	5.2	5.5	8.2	9.7	15.9	21.9	20.0	24.7
Free World	1.9	5.5	5.7	8.9	11.9	19.9	26.2	28.7	34.9
Percent of Free World Total	95	95	96	92	82	80	84	70	71

pounds. This net import requirement should increase substantially as the USA moves to meet its unfilled requirements from lower-cost imports.

3. As a net importer and in order to minimize risk, it would be prudent for the US industry to spread its sources geographically, in a manner similar to the Japanese, so as not to become too dependent on any single supply source. South Africa must be considered since it is the world's second largest exporter of uranium and because of its impeccable delivery record. Furthermore, South Africa offers a real alternative to Canadian pricing and upgrading policies as well as to the uncertainties of Australian government and labor policies towards uranium exploitation.

4. There is a strong need for compromise by both countries on commercial terms. Whereas South Africa is accustomed to annual renegotiations at long-term contract prices above spot prices, US utilities have a preference to contract at prices related to the spot and near-term markets. US utilities are subject to the scrutiny of their Public Service Commissions, not to mention the public, and who can criticize transactions at market prices? Somewhere, with the aid of the market forces I have referred to, a compromise could be reached. For example, this could be realized with the mutual acceptance of "intermediate-term pricing," with the use of base pricing plus escalations with market overrides. In time we could see a convergence of spot and long-term prices and, who knows, we might one day see Nuexco quoting a "contract value" in addition to its Exchange Value!

5. Existing perceptions and attitudes need to change. US utility managers should travel to South Africa to see the country for themselves and to draw their own conclusions about the political and commercial desirabilities of doing business with us. Whereas some business has been done in the USA by Nufcor in the past, this has been confined largely to fuel fabricators, other producers and trading companies. Very few transactions have been conducted with US utilities. Furthermore, the Westinghouse litigation and the US antitrust lawsuits made the USA an uninviting place for Nufcor to do business during the 1970s, especially with the market opportunities that existed elsewhere at the time.

6. Finally, strict confidentiality would be necessary for South African producers and US utilities to contract with each other. Not only does our Atomic Energy Act require this, but as I have mentioned, the South African industry would want to prevent the market "feedback effect" which could jeopardize its existing situation. On the US side, utilities would no doubt prefer to avoid publicity, so as to minimize criticism and adverse publicity for trading with South Africa. This could be difficult to achieve given the reporting requirements of the PUCs. However, there are ways of contracting to reduce publicity, such as the use of intermediaries, swaps and even barter arrangements.

Conclusion

I have endeavored to provide you with a better understanding of the South African uranium industry, its economics, its structure and its modus operandi. I have also attempted to identify the unique market situation that has emerged between US utilities and South African producers. Finally, I have mentioned some of the forces and conditions that need to be recognized and met for this market situation to be exploited. Markets are dynamic and to succeed in them, timing is essential. It is Nuexco's belief that the time is right for the opportunity that exists to be exploited. Should we not act, other forces will doubtless emerge which could result in lost initiatives.

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EXECUTIVE SUMMARY
REPORT 189
(All data as of April 30, 1984)

Exchange Value $17.75, up $0.75	The **Exchange Value** is **$17.75** per pound U_3O_8, up $0.75 since last month. No recent uranium sales are reported, although three transactions concluded late in 1983, two involving long-term deliveries, are listed in this Report.
Supply-Demand Ratio rose to 2.2:1	Active spot and near-term **uranium supply** amounts to **7.4 million** pounds U_3O_8 equivalent, up 1.3 million pounds from last month. Active spot and near-term **uranium demand** totals **3.4 million** pounds, down 400 thousand pounds. The spot and near-term **supply-demand ratio** rose to **2.2:1.**
Transaction Value fell $1.35, to $17.90	The **Transaction Value** is **$17.90** per pound U_3O_8, down $1.35 since last month. It includes 10 transactions involving a total of 2.5 million pounds U_3O_8 and equivalent UF_6 and covers a period of 5 months.
Loan Use Charge Rate unchanged at 6%	The **Loan Use Charge Rate** remains **6 percent** per annum.
Conversion Value unchanged at $0.80	The **Conversion Value** is **$0.80** per pound U as UF_6, unchanged since last month. No secondary market conversion transactions are reported. Active secondary market supply of conversion services for delivery within three years totals 2.9 million pounds U as UF_6; no active demand is reported.
SWU Values $105 for DOE-origin (FY85) $80 for non-DOE origin (delivery within 15 months)	The **SWU Values** are **$105** per SWU of DOE origin and FY85 delivery, up $5 since last month, and **$80** per SWU of non-DOE origin, unchanged since last month. Four SWU transactions are reported, involving a total of 240 thousand SWUs. Active secondary market SWU supply amounts to approximately 1.7 million SWUs, while active demand totals 625 thousand SWUs.
Japan	Annual negotiations between Japanese utilities and some of their important long-term uranium suppliers indicate that the downward price trend of recent years has slowed considerably.
South Africa	The Beisa mine will be shut down this year. Nationally, first quarter production results were consistent with South Africa's stable production rate.
Analysis and Commentary	An analysis of recent progress made on non-US nuclear power units under construction confirms the strength of the programs in Japan and France, and shows that non-US nuclear generating capacity is likely to grow considerably during the next two years.
Basic Considerations	The deenrichment swap is probably the most common form of secondary market SWU transaction, and this Report explains the mechanics of it.
Focus	Japan has developed advanced centrifuge enrichment technology, although plans for commercial-scale facilities are likely to develop slowly.
Raw Materials	This Report presents the second half of a two-part article on the Rossing project in Namibia.

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CURRENT MARKET DATA

NUEXCO MARKET DATA
Report 189
April 30, 1984

	Market Values	Active Supply[1] (thousands)	Active Demand[1] (thousands)
Exchange Value	**$17.75** lb. U_3O_8	7,410	3,380
Conversion Value	**$0.80** lb. U in UF_6	2,930	0
SWU Values			
DOE origin, FY85 delivery	**$105** SWU	1,705	625
non-DOE origin, delivery within 15 months	**$80** SWU		
Loan Use Charge Rate	6% annum	5,545	250

Transaction Value	$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
	17.90	2.5	10	5

DEFINITIONS

1. The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.
2. The Conversion Value is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.
3. The SWU (Separative Work Unit) Values represent Nuexco's judgment of the price at which transactions for the sale of significant quantities of SWUs of stated origin for delivery in the specified time period could be concluded as of the date indicated.
4. The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.
5. The Transaction Value is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:
   a. Transactions closed within the previous three-month period for which delivery is scheduled within one year of the transaction date;
   b. At least ten transactions;
   c. Transactions involving a sum total of at least 2 million pounds U_3O_8 equivalent.

   The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars using conversion rates in effect on or near the transaction date.

DERIVATIONS

1. All Market Values are based on:
   a. Data from recently completed transactions.
   b. Data from pending transactions.
   c. Firm bids to buy or borrow, and firm offers to sell or lend.
   d. Prices purchasers or rates borrowers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy or borrow, and prices sellers or rates lenders have expressed a willingness to offer, but for which Nuexco is not aware of firm offers to sell or lend.
2. For the SWU Values, Nuexco converts SWU prices at varying tails and product assays to equivalent SWU prices at the DOE Reference Transaction Tails Assay (presently 0.20 weight-percent U_{235}) and a product assay of 3.0 weight-percent U_{235}, assuming feed costs corresponding to Nuexco's Exchange and Conversion Values determined as of the same date.

COMMENTS

1. Prices associated with deliveries under old or renegotiated contracts or other than arm's-length transactions, are not considered in the determination of these Market Values.
2. In the determination of the Conversion Value, Nuexco does not consider transportation charges other than those customarily provided by primary suppliers of conversion services.
3. The price of conversion services or SWUs delivered under long-term contracts with primary suppliers are not considered in the determination of either the Conversion or SWU Values.
4. In calculating the Transaction Value, Nuexco does not consider the price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of future Exchange Values or any other indeterminate variable. Also excluded from consideration are all data in which the delivery price is defined in such a way that it cannot currently be determined.

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[1] Supply and demand tables in the *Current Market Data* section of this Report detail the numbers for each category. Quantities of SWUs are not referenced to SWUs of a particular origin.

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NUEXCO REPORT 189 FIGURES OF THE MONTH (April 30, 1984)	This Month (Report 189)	Last Month (Report 188)	12 Months Ago (Report 177)
Exchange Value[1]	17.75	17.00	23.25
Transaction Value[1]	17.90	19.25	21.40
Conversion Value[2]	0.80	0.80	1.20
Loan Use Charge Rate[3]	6%	6%	6%
Near-Term Uranium Supply[4]	7.4	6.1	8.6
Near-Term Uranium Demand[5]	3.4	3.8	2.6
Near-Term Supply-Demand Ratio	2.2	1.6	3.4
Recent Uranium Sales:			
Number of Transactions[6]	0*	9	6
Quantity of Material[7]	—	1.5-3.0	7.0-12.0
Nuexco SWU Values:[8]			
DOE origin, FY85 delivery	105	100	—
non-DOE origin, delivery within 15 months	80	80	—
USDOE SWU Prices:			
USEC	135.00	135.00	—
AFC	153.00[9]	153.00[9]	138.65
Requirements	157.00[9]	157.00[9]	149.85
Market Value of Enriched UF_6[10 11]:			
2.5 w/o U_{235}	555.72	530.76	616.52
3.0 w/o U_{235}	715.89	683.62	789.24
3.5 w/o U_{235}	879.36	839.63	965.04
4.0 w/o U_{235}	1,045.09	997.79	1,143.13

---

*Three transactions from late 1983 are reported.

[1] US $ per pound U_3O_8 equivalent.

[2] US $ per pound U as UF_6.

[3] Per annum.

[4] Active inquiries to sell, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[5] Active inquiries to purchase, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[6] Uranium sales only; does not include loans, conversion, or SWU transactions.

[7] Millions of pounds U_3O_8, equivalent.

[8] US $ per SWU.

[9] Effective 10/1/84.

[10] Calculated using the Nuexco Exchange Value, Conversion Value, and 0.20 percent tails assay. From 2/28/83 through 9/30/83, calculations used the Nuexco SWU Value for the relevant fiscal year. From 10/31/83 through 2/29/84, calculations used the Nuexco SWU Value for DOE origin and FY84 delivery. As of 3/31/84, calculations use the Nuexco SWU Value for DOE origin and FY85 delivery.

[11] US $ per KgU as UF_6.

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MAY 1984 NUMBER 189

Monthly Report on the Nuclear Fuel Market

NUEXCO

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MONTHLY REPORT ON THE NUCLEAR FUEL MARKET
May 1984 No. 189

R. WESLEY MILLER, *EDITOR* JAMES J. LIGHTNER, *ASSOCIATE EDITOR*

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To Our Readers

Nuexco will host a hospitality suite during the International Nuclear Conference sponsored by the Canadian Nuclear Association, Uranium Institute and Canadian Nuclear Society in Saskatoon, Saskatchewan, Canada, June 3–6. The suite will be located in The Holiday Inn. We look forward to seeing you there.

* * *

Included with this Report is a copy of a speech entitled *South Africa's Role in the Uranium Market*, given by Chris I. Von Christierson, Nuexco's representative in the Republic of South Africa, at Nuexco's luncheon during the Atomic Industrial Forum Fuel Cycle Conference in Atlanta on April 2.

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NATURAL URANIUM AND CONVERSION

The **Exchange Value** as of April 30, 1984 is **$17.75** per pound U_3O_8, up $0.75 since last month. The *Current Market Data* section of this Report lists three uranium sales transactions, involving a total of approximately five million pounds U_3O_8, but all three were concluded at the end of 1983. Two involved long-term deliveries and one involved deliveries in the first half of this year.

Active supply of uranium (U_3O_8 and UF_6) for spot and near-term delivery totals **7.4 million** pounds U_3O_8 or equivalent UF_6, up 1.3 million pounds from last month. The corresponding figure for **active demand** is **3.4 million** pounds, down 400 thousand pounds. The spot and near-term **supply-demand ratio** rose to **2.2:1.**

The **Transaction Value** as of April 30, 1984 is **$17.90** per pound U_3O_8, down $1.35 since last month. The current Transaction Value includes 10 transactions involving a total of 2.5 million pounds U_3O_8 or equivalent UF_6 and covers a period of 5 months.

The **Loan Use Charge Rate** as of April 30, 1984 is **6 percent** per annum, unchanged since last month. No uranium loans are reported.

* * *

The Exchange Value rose $0.75 to $17.75 after the aggressive selling that occurred during March largely subsided. The elimination of a substantial quantity of bargain-priced inventory during March, and the subsequent rise in the overall level of offering prices during April, caused discretionary buyers to reassess the market. Most buyers' inquiries during April were aimed at obtaining prices at or below last month's Exchange Value of $17.00. Sellers' offering prices, on the other hand, were in most cases several dollars above that level. As a result, no new near-term uranium sales transactions were concluded during April. A few active sellers appear willing to offer at or below the $18.00 level, however, and their number may increase if buyers continue to exhibit hesitation, or if new bargain-priced inventory enters the market.

Transaction Value Definition

The definition of the Transaction Value has been revised slightly this month to clarify that sales of natural uranium, *including natural* UF_6, may be included in the calculation. The original definition had made reference only to "... prices paid for U_3O_8 ...", thereby implying the exclusion of natural UF_6.

* * *

The **Conversion Value** as of April 30, 1984 is **$0.80** per pound U as UF_6, unchanged since last month. No conversion transactions are reported. Active secondary market supply of conversion services for delivery within three years totals 2.9 million pounds U as UF_6, but *no* active demand is reported.

Active conversion sellers did not have the occasion to alter their offering prices during April. For buyers interested in secondary market conversion services, $0.80 per pound U would be a representative price. However, buyers interested in purchasing concentrates have shown no willingness to pay for the conversion component of natural UF_6, so sellers of natural UF_6 have been offering at prices that assign a zero value to the conversion component. For example, a seller of natural UF_6 wishing to offer at a price equivalent to $17.00 per pound U_3O_8 would price the material at $44.42 per kgU in UF_6.

SECONDARY MARKET ENRICHMENT SERVICES

The secondary market **SWU Values** as of April 30, 1984 are **$105** for **DOE origin** and **FY85 delivery,** up $5 since last month, and **$80** for **non-DOE origin** and delivery within approximately 15 months, unchanged. The *Current Market Data* section of this Report lists four secondary market SWU transactions involving a total of 240 thousand SWUs. Active secondary market supply of enrichment services totals approximately 1.7 million SWUs, up somewhat from last month, while active demand amounts to 625 thousand SWUs, the same level as last month.

* * *

The price rise for DOE origin SWUs can be attributed *not* to a growing firmness in demand, but to the expectation thereof. Current demand is comprised principally of ISC holders and Requirements contract holders that plan to convert to the USEC. DOE permits the former category of buyers, ISC holders, to buy up to 60 percent of their FY85 requirements on the secondary market and permits the latter group to buy up to 30 percent, so the market potential is well known to sellers. Furthermore, several holders of Requirements contracts bought secondary market SWUs for FY84 delivery in anticipation of converting to the USEC, so their high potential as customers for FY85 SWUs is also well known to sellers. In this context, it is important to note that an important part of the anticipated demand comes from those DOE cus-

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tomers in Europe and Asia that plan to convert to the USEC. As a result of this expectation of increased demand, sellers and buyers alike share the expectation of upward pressure on secondary market prices for DOE origin SWUs. Finally, sellers would prefer to wait as long as practical to compete aggressively for the available demand, primarily because that strategy delays the date they will be required to pay the discounts necessary to effect SWU contract assignments. (See page 25 in this Report for an article describing common mechanisms for secondary market SWU transactions.)

* * *

The **non-DOE origin SWU Value** stayed at approximately $80 during April, as non-DOE sellers continued to offer low prices in competition for the business of utilities free to purchase non-DOE SWUs. While the $80 price leve reflects secondary market offering prices, primary market prices for non-DOE SWUs are not considerably higher than that level.

NEW USDOE SWU PRICES

On April 4, 1984, DOE published in the Federal Register its new prices for enrichment services as follows:

1. Utility Services enrichment contracts (USEC): $135.00 per SWU, effective immediately;
2. Fixed-Commitment contracts: $153.00 per SWU, effective October 1, 1984;
3. Requirements contracts: $157.00 per SWU, effective October 1, 1984.

The price increases for enrichment services delivered under Fixed-Commitment and Requirements contracts reflect an extension of DOE's existing pricing policy. This policy assigns risk levels to future sales slippage based on historical comparisons. In theory, a more stable sales base means less risk of slippage and lowers the price increase necessary.

In the latest announcement, DOE assigned a 16-percent risk of slippage to sales under Fixed-Commitment contracts and a 19-percent risk factor to sales under Requirements contracts. DOE views the USEC as providing the most stable sales base.

The risk percentages were calculated by comparing the change between the SWU sales forecast and actual sales made over a specific period. Surcharges were based upon the difference.

The increases in the Fixed-Commitment and Requirements contract prices were generally in line with industry expectations. It had been anticipated that DOE would create a significant price differential between the USEC and the other two types in order to provide an incentive for holders of Fixed-Commitment and Requirements contracts to convert to the USEC. So far it would appear that most contract holders are planning to do so. A few holders of 3.5-year Requirements contracts and some European customers of DOE have indicated that they do not plan to convert now, if ever. In the meantime, Urenco and Eurodif, DOE's European competitors, are making an aggressive push for US market share by offering long-term contracts having terms as favorable as those in the USEC and at significantly lower prices.

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CURRENT MARKET DATA

EXCHANGE VALUE $17.75/lb. U_3O_8 Determined as of April 30, 1984

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE[1]
Determined as of April 30, 1984

$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
17.90	2.5	10	5

Definition

The Transaction Value is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:

A. Transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date;
B. At least ten transactions;
C. Transactions involving a sum total of at least two million pounds U_3O_8 equivalent.

The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars as of the transaction date.

Comments

Nuexco does not consider the following in determining the Transaction Value:

A. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.
B. The price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of Exchange Value or any other independent variable.
C. Transactions in which the delivery price is defined in such a way that it cannot currently be determined.

[1] Transaction Values for 1976 through 1981 and their associated parameters (millions of pounds, number of transactions and number of months) are tabulated on pages 31 and 32 of Report 161. The corresponding data for 1982 are tabulated on page 5 of Report 173, and for 1983 on page 5 of Report 186.

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CURRENT MARKET DATA

LOAN USE CHARGE RATE[1] 6%
Determined as of April 30, 1984

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrows and lenders have expressed as a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

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[1] Monthly data for 1968 through 1981 appear on pages 32-34 of Report 162. Monthly data for 1982 appear on page 2 of Report 173.

CONVERSION VALUE $0.80/lb. U as UF_6
Determined as of April 30, 1984

Definition

The Conversion Value is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.

Derivation

Nuexco bases the Conversion Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Conversion Value:

A. The price of conversion services delivered or to be delivered under old contracts.
B. The price of conversion services delivered in connection with contract renegotiations or other than arm's length transactions.
C. Transportation charges other than those customarily provided by primary suppliers of conversion services.

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SWU VALUES

$105/SWU FOR DOE ORIGIN AND FY85 DELIVERY
$80/SWU FOR NON-DOE ORIGIN AND DELIVERY WITHIN 15 MONTHS
Determined as of April 30, 1984

Definition

The SWU (Separative Work Unit) Values represent Nuexco's judgment of the price, expressed in US dollars per SWU, at which transactions for the sale of significant quantities of SWUs of stated origin for delivery in the specified time period could be concluded as of the date indicated.

Derivation

Nuexco bases the SWU Values upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.
E. SWU prices at varying tails assays and varying product assays are converted to the equivalent SWU price at the DOE Reference Transaction Tails Assay (presently 0.20 weight percent U_{235}) and a product assay of 3.0 weight percent U_{235} assuming feed costs calculated using the Nuexco Exchange Value and Nuexco Conversion Value determined as of the last day of the same month.

Comments

Nuexco does not consider the following in determining the SWU Values:

A. The price of SWUs delivered under long-term contracts from primary suppliers, such as DOE, Urenco, or Eurodif.
B. The price of SWUs delivered under other than arm's length transactions.

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CURRENT MARKET DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
	This Month (Apr. 30, 1984)	Last Month (Mar. 31, 1984)	12 Months Ago (Apr. 30, 1983)	This Month (Apr. 30, 1984)	Last Month (Mar. 31, 1984)	12 Months Ago (Apr. 30, 1983)
Australia (dollar)	19.30	18.12	26.79	50.18	47.11	69.64
Belgium (comm. franc)	973.14	905	1,134	2,530	2,353	2,949
Canada (dollar)	22.73	21.73	28.52	59.10	56.50	74.14
Finland (markka)	101.66	94.34	126.43	264.30	245.26	328.68
France (franc)	147.43	135.24	171.46	383.27	351.60	445.76
FRG (mark)	48.01	43.92	57.22	124.82	114.17	148.77
Italy (lira)	29,697	27,490	34,191	77,206	71,469	88,889
Japan (yen)	4,020	3,805	5,532	10,452	9,892	14,381
Netherlands (guilder)	54.12	49.53	64.35	140.69	128.78	167.30
South Africa (rand)	22.12	21.01	25.34	57.50	54.63	65.88
Spain (peseta)	2,696	2,518	3,185	7,010	6,547	8,280
Sweden (krona)	141.21	130.87	173.90	367.11	340.23	452.09
Switzerland (franc)	39.64	36.37	48.04	103.05	94.56	124.89
UK (pound)	12.66	11.71	14.91	32.90	30.43	38.77
US (dollar)	17.75	17.00	23.25	46.15	44.20	60.44

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
	This Month (Apr. 30, 1984)	Last Month (Mar. 31, 1984)	12 Months Ago (Apr. 30, 1983)	This Month (Apr. 30, 1984)	Last Month (Mar. 31, 1984)	12 Months Ago (Apr. 30, 1983)
Australia (dollar)	19.46	20.52	24.65	50.60	53.34	64.10
Belgium (comm. franc)	981.36	1,025	1,044	2,551	2,665	2,714
Canada (dollar)	22.93	24.61	26.25	59.60	63.97	68.24
Finland (markka)	102.52	106.83	116.37	266.53	277.72	302.53
France (franc)	148.67	153.14	157.82	386.51	398.14	410.29
FRG (mark)	48.42	49.73	52.67	125.87	129.28	136.93
Italy (lira)	29,948	31,129	31,471	77,858	80,928	81,816
Japan (yen)	4,054	4,308	5,092	10,540	11,201	13,237
Netherlands (guilder)	54.57	56.09	59.23	141.88	145.82	153.99
South Africa (rand)	22.31	23.79	23.32	57.99	61.86	60.64
Spain (peseta)	2,719	2,851	2,932	7,069	7,413	7,621
Sweden (krona)	142.40	148.19	160.06	370.21	385.26	416.12
Switzerland (franc)	39.97	41.19	44.21	103.92	107.07	114.95
UK (pound)	12.76	13.26	13.73	33.18	34.46	35.69
US (dollar)	17.90	19.25	21.40	46.54	50.05	55.64

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[1] Calculated using currency exchange rates published in the *Wall Street Journal* on April 30, 1984.

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CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

	per lb. U as UF6			per kg. U as UF6		
Country (currency)	**This Month (Apr. 30, 1984)**	**Last Month (Mar. 31, 1984)**	**12 Months Ago (Apr. 30, 1983)**	**This Month (Apr. 30, 1984)**	**Last Month (Mar. 31, 1984)**	**12 Months Ago (Apr. 30, 1983)**
Australia (dollar)	0.87	0.85	1.38	1.92	1.88	3.05
Belgium (comm. franc)	43.86	42.60	58.54	96.69	93.91	129.05
Canada (dollar)	1.02	1.02	1.47	2.26	2.25	3.25
Finland (markka)	4.58	4.44	6.53	10.10	9.79	14.39
France (franc)	6.64	6.36	8.85	14.65	14.03	19.51
FRG (mark)	2.16	2.07	2.95	4.77	4.56	6.51
Italy (lira)	1,338	1,294	1,765	2,951	2,852	3,891
Japan (yen)	181.20	179.05	285.51	399.48	394.74	629.44
Netherlands (guilder)	2.44	2.33	3.32	5.38	5.14	7.32
South Africa (rand)	1.00	0.99	1.31	2.20	2.18	2.88
Spain (peseta)	121.53	118.50	164.38	267.92	261.25	362.40
Sweden (krona)	6.36	6.16	8.98	14.03	13.58	19.79
Switzerland (franc)	1.79	1.71	2.48	3.94	3.77	5.47
UK (pound)	0.57	0.55	0.77	1.26	1.21	1.70
US (dollar)	0.80	0.80	1.20	1.76	1.76	2.65

SWU VALUES EXPRFSSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU FY85	Non-DOE SWU delivery within 15 months
Australia (dollar)	114.17	86.98
Belgium (comm. franc)	5,757	4,386
Canada (dollar)	134.48	102.46
Finland (markka)	601.37	458.19
France (franc)	872.09	664.45
FRG (mark)	284.01	216.39
Italy (lira)	75,673	133,846
Japan (yen)	23,783	18,120
Netherlands (guilder)	320.12	243.90
South Africa (rand)	130.84	99.69
Spain (peseta)	15,950	12,153
Sweden (krona)	835.32	636.44
Switzerland (franc)	234.48	178.65
UK (pound)	74.87	57.04
US (dollar)	105.00	80.00

[1] Calculated using currency exchange rates published in the *Wall Street Journal* on April 30, 1984.

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CURRENT MARKET DATA

RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
2814	1983-92	1,001-1,500	unknown	US Producer	US Utility	Took place late 1983.
2809	1987-96	3,000-5,000	unknown	US Producer	US Utility	Took place late 1983.
2798	1984	101-300	110-125	US Producer	US Producer	Took place late 1983.

Secondary Market Enrichment Services

Nuexco Transaction Number	Delivery Period[2]	Approximate Quantity (thousands of SWUs)	Approximate Price[3] as Percent of Current SWU Value[4]	Tails Assay (Percent U_{235})	Seller Group	Buyer Group	SWU Origin	Remarks
2823	1985-6	50-100	110 (see remarks)	0.3	US Utility	US Utility	DOE	Discount from USEC price, so 1986 price is indeterminate.
2804	1984	less than 50	unknown	0.2	US Utility	US Utility	DOE	
2800	1984	50-100	103	0.2	US Entity	US Utility	Eurodif	
2789	1984	50-100	93	0.2	US Utility	US Utility	DOE	

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[1] Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.

[2] Refers to calendar year, not fiscal year.

[3] Price is not normalized to 0.20% tails assay.

[4] Refers to SWU Value for same origin as SWUs included in transaction.

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URANIUM SUPPLY
(As of 4/30/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
1575	—	500 per year	
1818	—	500 per year	
2038	1,000	—	UF_6
2134	220	—	
2201	95	—	
2236	—	200 per year	1985-89
2263	—	500 per year	1985-90
2275	145	—	
2297	—	200 per year	1985-89
2307	880	—	UF_6
2315	450	950	UF_6
2320	330	—	UF_6
2326	—	3,500	1988-91
2335	275	—	
2336	—	250 per year	
2365	20	—	
2368	—	2,800	
2376	340	—	UF_6
2389	300	—	
2390	100	—	
2392	35	—	UF_6
2436 A	850	—	enriched UF_6
2484	130	—	
2505	280	—	U_3O_8 or UF_6
2509	990	1,400	UF_6
2565	400	—	
TOTAL:	7,410		
INACTIVE			
0564	—	1,000 per year	1985-90
2017	1,100	1,200	
2191	125	—	UF_6
2193	—	800 per year	1986-90
2271	—	500 per year	1984-88
2429	450	—	
2473	—	500 per year	1984-90
2483 A	545	—	
2495	130	—	UF_6
2557	860	—	
TOTAL:	3,210		

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[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

URANIUM DEMAND
(As of 4/30/84)

	Delivery Period[1] (Thousands of Pounds U_3O_8)		
Nuexco Project Number	**Spot or Near-term[2]**	**Intermediate or Long-term**	**Remarks**
Inquiries to Purchase:			
ACTIVE			
2217	—	1,000 per year	1988-95
2329	—	500	1985
2352	240	—	
2355 A	—	1,400	enriched UF_6
2399 A	—	130	1985
2411	400	—	
2419	80	—	UF_6
2445	—	250 per year	1988-93
2456	650	—	UF_6
2463	260	—	UF_6
2481	100	—	
2492	600	2,000	1984-89
2494	250	250 per year	1984 on
2508	65	—	UF_6
2558	235	—	UF_6
2566	500	—	
TOTAL:	3,380		
INACTIVE			
1999	—	50 per year	1985-90
2244	—	350 per year	
2303	—	275 per year	1985-90
2372	—	250 per year	1985-88
2413	—	250 per year	1986-88
2414	—	150 per year	1987-91
2457	—	650	1987
TOTAL:	—		

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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LOAN SUPPLY AND DEMAND
(As of 4/30/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Within 1 Year	Beyond 1 Year	Remarks
Available for Loan: ACTIVE			
1938	2,000	—	UF_6
2128	1,000	—	
2139	2,000	—	
2483 B	545	—	
TOTAL:	5,545		
Inquiries to Borrow: ACTIVE			
2493	250	—	
TOTAL:	250		

[1] Measured from the date of this Report.

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CURRENT MARKET DATA

CONVERSION SUPPLY AND DEMAND
(As of 4/30/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF$_6$) Within 3 Years	Beyond 3 Years	Remarks
Available for Sale:			
ACTIVE			
2051	1,000	—	
2141	2,600	—	
2511	330	330	1986-90
TOTAL:	2,930		
INACTIVE			
1936	1,000	—	
2401	600	—	
2438	220	220	1985-87
TOTAL:	1,820		
Inquiries to Purchase:			
INACTIVE			
2420	300	—	1986
TOTAL:	300		

[1] Measured from the date of this Report.

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SWU SUPPLY
(As of 4/30/84)

Nuexco Project Number	**Delivery Period[1] (Thousands of SWUs)** Spot or Near-term[2]	Intermediate or Long-term	**Remarks**
Available for Sale: ACTIVE			
2100	—	100 per year	1986-87
2192	100	210	1986-87
2285	500	3,000	
2345	150	—	
2351	—	250 per year	1986-88
2378	130	250 per year	1987-88
2408	160	—	
2428	80	—	
2436 B	185	—	enriched UF_6
2469	—	80	1987
2510	400	—	
TOTAL:	1,705		

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[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

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CURRENT MARKET DATA

SWU DEMAND
(As of 4/30/84)

	Delivery Period[1] (Thousands of SWUs)		
Nuexco Project Number	Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2237	—	400 per year	1987-90
2346	—	30	1986
2355 B	—	600	enriched UF_6
2400	80	—	
2407	75	130	1986
2412	85	—	
2448	20	—	
2452	30	—	1985
2475	300	300 per year	1988-90
2491	—	80 per year	1987 on
2503	—	330	1986
2552	35	—	
TOTAL:	625		
INACTIVE			
2142	35	—	
2432	50	500	
2440	—	20 per year	1988-91
2449	50	—	
2459	50	50 per year	
2471	60	40 per year	
2512	—	15 per year	1987 on
2567	—	45 per year	1987 on
TOTAL:	245		

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

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JAPAN

Annual price negotiations between Japanese utilities and some of their important long-term uranium suppliers indicate that the downward price trend of recent years has slowed considerably. During March and April, a group of Japanese utilities agreed to pay $33 to $34 per pound U_3O_8 for 1985 deliveries (fiscal year ending March 31, 1985) from African and European suppliers. While the individual contract prices may be slightly lower than 1984 or slightly higher, the range of $33 to $34 is essentially unchanged since last year.

The *unweighted* average of the agreed prices for 1985 deliveries comes to almost exactly $33.50 per pound U_3O_8. That price level compares to $45 for 1981, $37.75 for 1982, $35.50 for 1983 and $33.70 for 1984. Thus, the agreed prices for 1985 deliveries reflect only minor adjustments based on the individual producers' situations. However, the ratio of these negotiated prices to the prices in the spot and near-term markets (as represented by the Nuexco Exchange Value) has changed substantially since last year. The ratio of the prices agreed for FY84 deliveries (approximately $33.70) to the February 28, 1983 Exchange Value ($21.75) is approximately 1.5:1. The corresponding ratio for FY85 deliveries is approximately 1.9:1, the highest such ratio in the past five years.

To whatever extent spot and near-term prices influence prices under long-term contracts, they almost certainly do not do so on the basis of any single month. It is much more likely that the annual price negotiations are influenced by the developments in spot and near-term prices since the previous year. For example, the price negotiations for FY85 deliveries were much more likely influenced by spot/near-term prices during FY84 (April 1, 1983–March 31, 1984) than by the February 1984 or March 1984 Exchange Values alone. Table 1 shows a comparison for the past five years of annually negotiated prices versus individual Exchange Values and also versus a 12-month average.

Comparing agreed prices to the Exchange Value immediately preceding the onset of negotiations, assuming they take place in March of each year, yields a ratio of 1.2 for FY81 deliveries, 1.5 for FY82, FY83 and FY84, but 1.9 for FY85. That would seem to imply that Japanese utilities are much more willing than before to pay a premium over spot/near-term market prices in exchange for the security of long-term supply. That simply is not the case. A more meaningful comparison is that using the 12-month simple average of Exchange Values for a given fiscal year. For example, the average of Exchange Values for FY84 (April 1, 1983–March 31, 1984) was $22.10; comparing it to the agreed price of approximately $33.50 yields a ratio of 1.5, the same as for FY83 deliveries and less than the 1.7 associated with FY84 deliveries. Those figures are consistent with the idea that, while Japanese utilities want to receive some benefit from the continued depression of spot/near-term prices, they understand the pressures on their suppliers and do not wish to damage healthy long-term relationships for the sake of temporary gains.

Table 1

RESULTS OF ANNUAL JAPANESE URANIUM PRICE NEGOTIATIONS COMPARED TO EXCHANGE VALUE

Fiscal Year Ending March 31	Approximate Agreed Price ($/lb. U_3O_8)	Date of Exchange Value for Comparison	Exchange Value ($/lb. U_3O_8)	Delivery Price/ Exchange Value	Average E.V. for Preceding Japan FY (1980–84) ($/lb. U_3O_8)	Delivery Price/ Average E.V.
1981	45.00	February 29, 1980	38.00	1.2	41.17	1.1
1982	37.75	February 28, 1981	25.00	1.5	28.63	1.3
1983	35.50	February 28, 1982	23.00	1.5	23.65	1.5
1984	33.70	February 28, 1983	21.75	1.5	19.65	1.7
1985	33.50	February 29, 1984	17.50	1.9	22.10	1.5

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RECENT DEVELOPMENTS

SOUTH AFRICA

Beisa

General Mining Union Corporation Limited (Gencor) and St. Helena Gold Mines Limited announced on May 1 their intention to shut down the Beisa mine by the end of this year. In its 1983 annual report, St. Helena had announced that its net loss from uranium had increased from R0.6 million in 1982 to R22.1 million in 1983. The sharply increased losses, coming in spite of improved performance in the mining and metallurgical sections (1,060,000 tons milled in 1983 vs. 611,000 in 1982), were due mainly to a lower than expected recovery grade, as a result of which the mine had to purchase uranium from other concerns at substantially higher prices than in 1982 to meet its contractual obligations.

Under the terms of an agreement between St. Helena and Beisa Mines Limited (Beisa), a subsidiary of Gencor, St. Helena acquired Beisa's mining rights and certain other assets on January 1, 1981. It has been operating the mine since, while Beisa has remained responsible for funding operating losses and capital expenditures.

As announced May 1, St. Helena has decided to discontinue mining and ore treatment operations at Beisa. Arrangements have been made with Nuclear Fuels Corporation of South Africa (Proprietary) Limited, whereby Nufcor has agreed in principle to accept assignment of all obligations under the 1978 uranium supply agreement. Proceeds from the sale of assets, including housing, are expected to cover the major portion of the remaining liabilities relating to the mine.

It is unlikely that the Beisa mine will be able to operate profitably for the foreseeable future. Therefore, the mine will not be placed on a care and maintenance basis but will be completely shut down. Spot uranium prices have fallen to such an extent that negotiated contract prices are little different from those available when Beisa went into production in 1981. At the same time, costs have been increasing at an average rate of about 16 percent per annum. Thus, the cost of production is now 50 percent higher than in 1981, but prices have remained static and even at these low levels are coming under increasing pressure. When Beisa was opened it was hoped that prices would move up, and costs and contracts were entered into on that basis. However, customers have been negotiating lower and lower prices as the uranium market has fallen.

Being a primary uranium producer with gold as the by-product, Beisa has not been able to rely on its gold production to remain profitable. Its demise will reduce South Africa's annual uranium production by approximately 1,000,000 pounds U_3O_8.

First Quarter Production

Uranium production in the Republic of South Africa remained steady during the first quarter of 1983, according to recent figures released by the Chamber of Mines. Total first quarter results of approximately 3,848,000 pounds U_3O_8 from Chamber of Mines producers compares to fourth quarter 1983 production of approximately 3,871,000 pounds (Table 2). Lower production from Chemwes (down 13.9 percent), Buffelsfontein (down 13.4 percent) and JMS (down 15.2 percent) was largely offset by higher production from Blyvooruitzicht (up 22 percent), Vaal Reefs (up 7.3 percent) and Beisa (up 10.9 percent).

Table 2

REPUBLIC OF SOUTH AFRICA:
FIRST QUARTER 1984 URANIUM PRODUCTION[1]
(Thousands of Pounds U_3O_8)

Operation	Fourth Quarter 1983	First Quarter 1984	Percent Change
Beisa	305	338	+10.9
Blyvooruitzicht	127	155	+22.0
Buffelsfontein	362	313	-13.4
Chemwes (Stilfontein)	360	310	-13.9
Driefontein Consolidated	105	98	- 6.7
ERGO[2]	106	113	+ 6.6
Harmony	310	307	- 1.0
Hartebeestfontein	246	248	+ 0.8
JMS[3]	420	356	-15.2
Randfontein	281	287	+ 2.1
Vaal Reefs	996	1,069	+ 7.3
Western Areas	164	175	+ 6.7
Western Deep Levels	89	79	-11.2
TOTAL	3,871	3,848	- 0.6

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[1] Excludes Palabora Mining Company, which is not a member of the Chamber of Mines.

[2] ERGO = East Rand Gold and Uranium Co. Ltd.

[3] JMS = Free State Joint Metallurgical Scheme.

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In reviewing the variations in uranium production from South Africa's gold-uranium by-product operations, it is important to recognize that the mining operation is controlled by gold, not uranium. Thus, South African producers may experience somewhat greater short-term variations than conventional producers elsewhere. Some specific comments regarding first quarter 1984 operations relative to the fourth quarter of 1983 are as follow.

1. **Beisa (St. Helena)**—Average yield (U_3O_8 per ton treated) increased 8.2 percent and tons treated increased 1 percent. 1984 production should total approximately 550,000 pounds U_3O_8.
2. **Blyvooruitzicht**—Average yield increased 18 percent and tons treated increased 3 percent.
3. **Buffelsfontein**—Average yield declined 14.3 percent and 1 percent fewer tons were treated.
4. **Chemwes (Stilfontein)**—Average yield declined 6 percent and tons treated declined 4 percent.
5. **JMS**—Output declined 15.2 percent as the amounts of slimes and flotation concentrates treated decreased by 15.7 percent and 14.4 percent, respectively.
6. **Randfontein**—An 8-percent decline in tons treated largely offset a 14-percent increase in average yield. Randfontein's profit on uranium sales declined almost 50 percent, from R3.7 million to R1.9 million, because of lower contract prices and reduced demand from its only customer. The balance of the company's long-term loan (from its customer) declined to R60.9 million as of March 31, 1984; the company has indicated it will not reduce the loan repayment rate in conjunction with falling demand, but that it intends to continue repaying the loan as though the customer were taking its full quota of uranium deliveries.
7. **Vaal Reefs**—Average yield increased 4.5 percent and tons treated increased 5.2 percent.
8. **Western Areas**—Profit on uranium operations almost doubled, from R1.72 million to R3.37 million. The company expects to maintain production at current levels for most of this year because of high contract deliveries. Uranium sales in 1983 were lower due to portions of 1983 commitments having been delivered in advance in 1982. The balance of their customer loan has been reduced to R27 million, with R640,000 in repayments due within the year.

Palabora

Separately, Palabora Mining Company (PMC) announced sales and shipments totalling approximately 502,000 pounds U_3O_8 during the first quarter of 1984. That total included a shipment of approximately 195,000 pounds, originally scheduled for delivery in 1981, that had been postponed to January 1984 at the request of the customer. First quarter production results for PMC are not available. As reported in Report 188, PMC produced 482,000 pounds U_3O_8 in 1983, which equates to a quarterly production rate of approximately 120,000 pounds.

Other Developments

Some other comments on individual production facilities that have longer-term implications are as follows.

1. **Harmony**—The company announced on March 12 that it had decided to discontinue production at the Merriespruit uranium plant (Report 188, page 18). That plant accounted for approximately 28 percent of Harmony's total uranium production. Thus, this action will reduce South Africa's annual production by about 400,000 pounds U_3O_8.

   Production from the Harmony and Virginia uranium plants, together with the existing stock of processor uranium, would be sufficient to meet the company's long-term committed sales. The closure of the Merriespruit plant will result in savings in operating costs and hence, small improvements in profits. The company is investigating the possibility of converting the Merriespruit uranium plant into a gold plant to treat tonnage from the new Harmony No. 4 shaft complex in 1986.
2. **Western Deep Levels**—The proposal to convert a portion of the uranium plant into a gold treatment facility (Report 188, page 18) has been approved by the board of directors of the company. The estimated escalated cost to completion is R35 million and the plan includes the erection of a milling plant and pulp-pumping plant capable of handling 120,000 tons per month. Commissioning is expected to take place by July 1985. The company plans to cease uranium production early in 1985 and will meet existing contracts from stockpiles and other arrangements. When that happens, it will reduce South Africa's annual output by approximately 400,000 pounds U_3O_8. However, the announced production target is approximately 350,000 pounds U_3O_8 from 1,660,000 tons treated at a recovery grade of .209 pounds U_3O_8 per ton.
3. **Randfontein**—Uranium operating profit for the year at R306.1 million was 39.5 percent higher than 1982, and the highest ever recorded. Planned expansion of the Cooke uranium plant to increase its capacity to 300,000 tons treated per month, together with modifications to improve efficiency of this plant, are progressing satisfactorily. Uranium profits over the next twelve months will be adversely affected by a further reduction in the con-

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tractual price as well as by a reduced offtake by the consumer.

4. **Western Areas**—During 1983, the planned tonnage buildup from uranium-bearing Middle Elsburg reef continued and 614,000 tons were treated. The uranium plant continued to operate at a high degree of efficiency on throughput lower than design capacity. Part of the increased tonnage planned to be mined in 1984 will be from Middle Elsburg reefs in order to meet recently negotiated contractual commitmens which require additional uranium oxide production of approximately 130,000 pounds U_3O_8 in each of the next three years.

CORRECTION

Last month's Report (Number 188) contains an error on page 21, in the table entitled "US Nuclear Power Plant Backlog." The fifth line of the table lists WNP Unit 1 where it should list WNP Unit 2. Unit 1 has been indefinitely delayed; Unit 2, however, received a full-power operating license in April 1984.

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NON-US NUCLEAR POWER PLANT BACKLOG

Construction Progress

As of January 1984, 98 units comprised the non-US nuclear power plant backlog (excluding Soviet bloc countries). Table 3 lists those 98 units by country in descending order of construction completion percentage. A unit enters the backlog when construction starts and exits when commercial operation begins. Thus, the backlog does not include units on which construction has not yet begun, such as eleven undergoing licensing in Japan. It also does not include units which have been delayed indefinitely, such as five in Spain.

Table 3 shows the construction completion percentage for each unit as of January 1982, and the change in completion percentage accomplished during the next two years. Table 4 shows a breakdown of the construction progress for all 98 units. The range of progress includes a remarkable 71 percent change in completion percentage achieved by Kansai Electric Power Company of Japan on Takahama Unit 3; it also includes twelve units on which a change of less than 5 percent was made.

Comparison Among Nations

Table 5 presents the current status of active nuclear power programs worldwide. The far-right column of Table 5 shows the average progress on backlog, a megawatt-weighted average of changes in completion percentages, accomplished in each country. A megawatt-weighted average takes account of the varying sizes of units, so that progress on a small unit is given less weight than progress on a large unit. The megawatt-weighted average progress on the entire non-US backlog was 26 percent, 11 percent greater than that for the USA. (See pages 20–21 of Report 188 for an analysis of the US backlog.)

Table 5 also lists the average size of the units under construction in each country, which puts a country's average progress in some perspective. Progress of 25 percent is more impressive when the average size of units under construction is 1100 MWe than when the average size is 600 MWe.

Table 6 ranks the countries that have active construction programs involving six or more units, including the USA, according to construction progress on their backlogs. Japan's average construction progress is by far the best in the world, largely because of the extensive preparation that precedes construction and the absence of delay between construction completion and commencement of commercial operation. (See the article entitled *Nuclear Power Plant Licensing in Japan* on pages 22–25 of Report 188.) France, which has the largest national backlog outside the USA, is progressing on the construction of its backlog almost twice as rapidly as the USA, despite a lack of demand for new capacity in France.

Table 4

CONSTRUCTION PROGRESS ON NON-US BACKLOG BETWEEN JAN. 1982 AND JAN. 1984 (As measured by changes in completion percentages)

Change in Completion Percentage[1]	Number of Units[2]
70–79	1
60–69	3
50–59	3
40–49	18
30–39	15
20–29	18
10–19	22
0–9	16
negative	1
Total	97

[1] As listed in Table 3 of this article.

[2] Excludes one unit in China for which data is not available.

Table 6

INTERNATIONAL RANKING OF NUCLEAR POWER PLANT CONSTRUCTION PROGRAMS

Country	Units Under Construction	Avg. MWe per Unit	Avg. Progress on Backlog[2]
Japan	10	925	48
France	23	1140	28
S. Korea	6	915	25
F.R. Germany	8	1040	23
United Kingdom	9	640	21
USA	46	1110	15
Canada	7	700	10
India	6	220	5

[1] Includes only those countries with 6 or more units currently defined as under construction.

[2] Average progress on backlog measures the average change in completion percentage for units under construction during the two-year period from Jan. 1982 to Jan. 1984, incorporating a MWe-weighted adjustment for differences in the size of those units. The calculation excludes units that began commercial operation during that period.

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ANALYSIS & COMMENTARY

Table 3
NON-US NUCLEAR POWER PLANT BACKLOG

Country	Unit	Net MWe	Utility[1]	Completion Percentage Jan. 1982[2]	Completion Percentage Jan. 1984[3]	Change in Completion Percentage
Argentina	Atucha 2	692	CNEA	3	25	22
Belgium	Doel 4	1000	Ebes	40	40	0
	Tihange 3	1000	Intercom	30	30	0
Brazil	Angra 1	626	Furnas	100	100	0
	Angra 2	1245	Furnas	10	10	0
	Angra 3	1245	Furnas	1	1	0
Canada	Pickering 6	516	Ontario Hydro	80	100*	20
	Bruce 6	750	Ontario Hydro	70	80	10
	Pickering 7	516	Ontario Hydro	70	80	10
	Bruce 5	750	Ontario Hydro	60	70	10
	Pickering 8	516	Ontario Hydro	60	70	10
	Bruce 7	750	Ontario Hydro	40	50	10
	Bruce 8	750	Ontario Hydro	35	40	5
	Darlington 2	881	Ontario Hydro	5	15	10
China	Quinshan	300	MNE	0	unknown	—
France	Paluel 1	1290	EDF	60	100*	40
	Chinon B2	870	EDF	80	100	20
	Cruas 2	880	EDF	60	98	38
	Cruas 3	880	EDF	50	98	48
	Paluel 2	1290	EDF	50	95	45
	Gravelines C5	910	EDF	40	85	45
	Creys Malville	1200	Nersa	60	85	25
	Cruas 4	880	EDF	40	85	45
	Paluel 3	1290	EDF	40	70	30
	Gravelines C6	910	EDF	30	70	40
	St. Alban 1	1300	EDF	25	70	45
	Flamanville 1	1290	EDF	30	65	35
	St. Alban 2	1300	EDF	40	55	15
	Cattenom 1	1265	EDF	30	55	25
	Paluel 4	1290	EDF	25	55	30
	Flamanville 2	1290	EDF	20	50	30
	Cattenom 2	1265	EDF	15	40	25
	Chinon B3	870	EDF	15	35	20
	Belleville 1	1275	EDF	15	35	20
	Chinon B4	870	EDF	10	25	15
	Nogent sur-Seine 1	1275	EDF	0	25	25
	Belleville 2	1275	EDF	3	21	16
	Nogent sur-Seine 2	1275	EDF	0	12	12
	Cattenom 3	1265	EDF	0	1	1
F.R. Germany	Kruemmel	1260	HEW/NWK	90	100*	10
	KRB II block B	1244	RWE/Bayernwerk AG	80	100*	20
	KKP 2	1268	Badenwerk/EVS	50	95	45
	THTR 300	296	HKG	75	85	10
	Grohnde	1290	Preag	55	85	30
	KRB 2 block C	1244	RWE/Bayernwerk AG	60	80	20
	Kaerlich	1227	RWE	40	80	40
	Kalkar SNR 300	295	SBK	50	75	25
	Isar 2	1285	KKI	0	20	20
	GKN 2	1230	GKN	0	5	5
India	Mapp 1	220	AEC	99	100	1
	Mapp 2	220	AEC	81	88	7
	Napp 1	220	AEC	57	40	(17)

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Table 3 (continued)

NON-US NUCLEAR POWER PLANT BACKLOG

Country	Unit	Net MWe	Utility[1]	Completion Percentage		Change in Completion Percentage
				Jan. 1982[2]	Jan. 1984[3]	
	Napp 2	220	AEC	18	30	12
	Kapp 1	220	AEC	0	13	13
	Kapp 2	220	AEC	0	13	13
Italy	Cirene	40	Enel	35	56	21
	Montalto 1	982	Enel	13	25	12
	Montalto 2	982	Enel	15	20	5
Japan	Fukushima II-2	1067	Tokyo EPC	66	100*	34
	Onagawa 1	500	Tohoku EPC	32	100	68
	Sendai 1	846	Kyushu EPC	60	100	40
	Takahama 3	830	Kansai EPC	21	92	71
	Fukushima II-3	1067	Tokyo EPC	23	85	62
	Kashiwazaki 1	1067	Tokyo EPC	39	85	46
	Takahama 4	830	Kansai EPC	9	75	66
	Fukushima II-4	1067	Tokyo EPC	13	70	57
	Sendai 2	846	Kyushu EPC	2	50	48
	Tsuruga 2	1115	JAPC	0	36	36
	Hamaoka 3	1066	Chubu EPC	0	15	15
S. Korea	Korea Nuclear 5	895	Kepco	70	90	20
	Korea Nuclear 6	895	Kepco	55	76	21
	Korea Nuclear 7	900	Kepco	17	60	43
	Korea Nuclear 8	900	Kepco	15	50	35
	Korea Nuclear 9	943	Kepco	6	22	16
	Korea Nuclear 10	943	Kepco	6	20	14
Mexico	Laguna Verde 1	654	CFE	67	75	12
	Laguna Verde 2	654	CFE	35	40	5
Philippines	PNPP 1	620	Napocor	23	70	47
South Africa	Koeberg 1	922	Escom	70	100	30
	Koeberg 2	922	Escom	50	96	46
Spain	Asco 2	887	Fecsa/Enher	75	98	23
	Cofrentes	930	Hidrola	74	98	24
	Trillo 1	997	UE/Endesa	10	44	34
	Vandellos 2	982	Fecsa/Enher	10	42	32
Sweden	Forsmark 3	1050	SSPB	20	75	55
	Oskarshamn 3	1050	OKG	30	65	35
Switzerland	Leibstadt	942	KKL	80	100	20
Taiwan	Maanshan 1	907	Taipower	46	94	48
	Maanshan 2	907	Taipower	25	78	53
UK	Heysham A1	625	CEGB	99	100	1
	Hartlepool R1	625	CEGB	99	100	1
	Dungeness B2	600	CEGB	98	100	2
	Hartlepool R2	625	CEGB	97	100	3
	Heysham A2	625	CEGB	87	100	13
	Heysham B1	660	CEGB	2	50	48
	Torness Pt. 1	660	SSEB	5	50	45
	Heysham B2	660	CEGB	1	35	34
	Torness Pt. 2	660	SSEB	2	35	33

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*Unit has begun commercial operation during 1984.

[1] See box on page 24 for list of acronyms used in this table.

[2] As listed in *Nuclear News* "World List of Nuclear Power Plants" of December 31, 1981.

[3] As listed in *Nuclear News* "World List" of December 31, 1983, or more recent publications.

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Table 5

ACTIVE NUCLEAR POWER PROGRAMS
(Excluding Soviet Bloc Nations)

Country	Units in Commercial Operation	MWe in Commercial Operation (rounded)	Units Under Construction	MWe Under Construction (rounded)	Avg. Size of Units Under Construction	Avg. Progress on Backlog[1] (MWe-Weighted)
Argentina	2	935	1	690	690	22
Belgium	5	3,450	2	2,000	1000	0
Brazil	0	0	3	3,115	1040	0
Canada	14	7,525	7	4,915	700	10
China	0	0	1	300	300	—
Finland	4	2,210	0	0	—	—
France	36	27,480	23	26,215	1140	28
FRG	13	12,260	8	8,135	1040	23
India	4	800	6	1,320	220	5
Italy	3	1,285	3	2,005	670	9
Japan	25	18,280	10	9,235	925	48
S. Korea	3	1,790	6	5,475	915	25
Mexico	0	0	2	1,310	655	9
Netherlands	2	495	0	0	—	—
Pakistan	1	125	0	0	—	—
Philippines	0	0	1	620	620	47
South Africa	0	0	2	1,845	920	38
Spain	6	3,910	4	3,795	950	29
Sweden	10	7,325	2	2,100	1050	45
Switzerland	4	1,940	1	940	940	20
Taiwan	4	3,110	2	1,815	910	51
UK	31	8,310	9	5,740	640	21
Yugoslavia	1	615	0	0	—	—
TOTAL NON-US	156	101,845	93	81,570	880	26
USA[2]	77	60,300	46	51,170	1110	15
TOTAL	233	162,145	139	132,740	957	22

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[1] Average progress on backlog measures the average change in completion percentage for units under construction during the two-year period from Jan. 1982 to Jan. 1984, incorporating an adjustment for differences in the size of those units.

[2] See Report 188 (April 1984) for an analysis of the current US nuclear power plant backlog.

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Table 7

UNITS THAT BEGAN COMMERCIAL OPERATION BETWEEN JAN. 1982 AND JAN. 1984

Country	Unit	Net MWe	Utility[1]	Percent Complete Jan. 1982[2]	COD
Argentina	Embalse 3	600	CNEA	85	Nov 1983
Belgium	Doel 3	900	Ebes	90	Oct 1982
	Tihange 2	900	Intercom	90	Feb 1983
Canada	Pt. Lepreau	640	New Brunswick	96	Jan 1983
	Pickering 5	516	Ontario Hydro	90	May 1983
	Gentilly 1	250	Hydro Quebec	92	Sep 1983
France	Blayais 2	910	EDF	95	Feb 1983
	St. Laurent de Eaux B2	880	EDF	100	Jun 1983
	Cruas 1	880	EDF	70	Aug 1983
	Blayais 4	910	EDF	80	Sep 1983
	St. Laurent de Eaux B1	880	EDF	100	Oct 1983
	Chinon B1	870	EDF	95	Oct 1983
	Blayais 3	910	EDF	95	Nov 1983
FRG	Grafenrheinfeld	1225	Bayernwerk AG	98	Jun 1982
Japan	Ikata 2	538	Shikoku EPC	98	Mar 1982
S. Korea	Korea Nuclear 2	605	Kepco	81	Jul 1983
	Korea Nuclear 3	629	Kepco	93	Apr 1983
Spain	Almaraz 2	930	Hidrola/UE/CSE	95	Nov 1983
	Asco 1	887	Fecsa/Enher	98	Dec 1983
Sweden	Ringhals 4	900	SSPB	100	Oct 1983
Taiwan	Kuosheng 2	951	Taipower	96	Mar 1983
UK	Dungeness B1	600	CEGB	100	Dec 1983

[1] See box on page 24 for list of acronyms used in this table.

[2] As listed in *Nuclear News* "World List of Nuclear Power Plants" of December 31, 1981.

Growth of Installed Capacity

Between January 1982 and January 1984, 22 units that were part of the non-US backlog in January 1982 began commercial operation. Table 7 lists those 22 units. Since January 1984, five units listed in Table 3 have begun commercial operation; those five, one each in Canada, France and Japan, and two in Germany, are denoted by an asterisk next to the completion percentage in Table 3. Withdrawing those five units leaves 93 units comprising the actual current non-US backlog.

Of the 93 units in the current backlog, a number are near the commercial stage. In fact, twelve units other than the five that recently began commercial operation are listed in Table 3 as 100-percent complete, which in most cases means they have begun some degree of operation. For example, Escom's Koeberg Unit 1 (South Africa) has been connected to the grid, and Furnas' Angra Unit 1 (Brazil) operated at 100-percent capacity recently. Table 8 lists the number of units in the current non-US backlog that are within each ten-percent range of completion percentage. Nearly 25 percent of the non-US backlog is between 90 and 100-percent complete. Fifty percent of the backlog is 70-percent complete or more. This data suggests that non-US nuclear electricity generating capacity, like that of the USA, will increase considerably within the next two to three years.

Table 8

COMPLETION PERCENTAGES OF UNITS IN NON-US BACKLOG

Percent Complete[1]	Number of Units[2]
90-100	21
80-89	12
70-79	13
60-69	3
50-59	10
40-49	7
30-39	8
20-29	9
10-19	6
0-9	3
Total	92

[1] As listed in Table 3 of this article.

[2] Excludes four units listed in Table 3 that have begun commercial operation during 1984, and one unit in China for which data is not available.

Acronyms Used in Tables 3 and 7

AEC = Atomic Energy Commission (India)
CEGB = Central Electricity Generating Board
CFE = Comision Federal de Electricidad
CNEA = Comision Nacional de Energia Atomica
CSE = Compania Sevillana de Electricidad S.A.
Ebes = Societes Reunies d'Energie du Bassin
EDF = Electricite de France
Endesa = Empresa Nacional de Electrica S.A.
Enel = Ente Nazionale per l'Energia Electrica
Enher = Empresa Nacional Hidroelectrica Ribagorzana
EPC = Electric Power Company
Escom = Electricity Supply Commission
EVS = Energie Versorgung Schwaben
Fecsa = Fuerzas Electricas de Cataluna S.A.
GKN = Gemeinschaftkernkraftwerk Neckar
HEW = Hamburgische Elektrizitatswerke
Hidrola = Hidroelectrica Española S.A.
HKG = Hochtemperatur-Kernkraftwerk GmbH
Intercom = Societe Intercommunale Belge de Gaz et d'Electricite
JAPC = Japan Atomic Power Company
Kepco = Korea Electric Power Corporation
KKI = Kernkraftwerk Isar
KKL = Kernkraftwerk Leibstadt AG
MNE = Ministry of Nuclear Energy (China)
Napocor = Philippine National Power Corporation
Nersa = Centrale Nucleaire Europeene a Neutrons Rapides S.A.
NWK = Nordwestdeutsche Kraftwerk
OKG = Oskarshamnsverkets Kraftgrupp Aktiebolag
Preag = Preussische Elekrizitats AG
RWE = Rheinisch-Westfalisches Elektrizitatswerk
SBK = Schnell-Bruter-Kernkraftwerksgesellschaft
SSEB = South of Scotland Electricity Board
SSPB = Swedish State Power Board
Taipower = Taiwan Power Company
UE = Union Electrica

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THE DEENRICHMENT SWAP

Introduction

A common form of transaction in the secondary market for enrichment services is the *deenrichment swap*. Through a deenrichment swap, an owner of enriched UF_6 (enriched product), or of a future commitment to take enriched product from a primary SWU supplier, gives title of that product to a buyer. In exchange, the buyer gives the seller an amount of natural UF_6 (usually an amount equivalent to that used to produce the enriched product), plus cash for the enrichment services.

Deenrichment swaps enable holders of unwanted inventories of enriched UF_6, or unwanted SWU commitments to a primary supplier, to dispose of them, usually in exchange for cash. The incentive for a buyer having natural UF_6 is the opportunity to purchase needed SWUs at a price below the primary market price.

Transaction Mechanism

The terms and conditions of a deenrichment swap transaction are established in a contract signed by the SWU seller and the SWU buyer. Such a contract ordinarily will contain the following information:

1. The quantity of enriched product to be transferred to the buyer, either directly by the seller or by the primary enricher at the instruction of the seller.
2. The product assay level of the enriched UF_6.
3. The tails assay at which the enriched product was, will be, or will be deemed to have been, enriched by the primary SWU supplier.
4. The number of SWUs required to produce the enriched UF_6, given the tails and product assay specifications.
5. The price to be paid by the buyer to the seller.
6. The amount of natural UF_6 to be transferred by the buyer to the seller (usually equivalent to the amount used to generate the enriched product according to the tails and product assay specifications of the contract).
7. The schedules for delivery of feed material (usually natural UF_6), enriched product, and cash.

In the case of a seller having an inventory of enriched product, that product may or may not be enriched to the assay level desired by the buyer. If the product in inventory has been enriched to an assay level less than the assay level desired by the buyer, it may be enriched further (upgraded) by a primary SWU supplier, either at the direction of the seller as part of the transaction, or at the direction of the buyer at a later date. Similarly, the actual tails assay at which the enriched inventory was produced may be different from that which the buyer would like to use in the transaction. The tails assay may be adjusted to suit the feed-to-product and SWU-to-product ratios necessary to conclude a transaction. (See the examples in Figures 1, 2 and 3.)

Alternately, in the case of a seller having a commitment to take future enrichment services from a primary SWU supplier, the seller must notify the primary supplier of the enrichment specifications a certain period of time in advance of delivery. (In most cases, this "advance notice period" has been 180 days for services provided by DOE.) The seller can dictate to the primary supplier the buyer's specifications for enriched product assay and quantity of enriched product, as contained in the contract signed between buyer and seller. In addition, holders of certain types of enrichment contracts may vary the tails assay within a specified range.

Ordinarily, delivery of enriched product in a deenrichment swap is accomplished by a simple book transfer from the seller's account to the buyer's account with the primary SWU supplier. In some cases, the product may be delivered directly to the buyer or to a fabricator. Normally, at the time of product delivery the buyer makes a cash payment to the seller for the SWUs involved. The buyer also delivers to a specified location, either actually or by book transfer, the quantity of natural UF_6 feed defined in the agreement.

Hypothetical Transaction

Suppose that Utility A needs 10,000 kgU of UF_6 enriched to 3.0 weight-percent U_{235} for a future reload. Using a tails assay of 0.3 weight-percent (w/o), Utility A's fuel manager calculates that 34,240 SWUs and 65,690 kgU of natural UF_6 feed are needed to generate the desired product. Utility A has a large inventory of natural UF_6, but does not have coverage for enrichment services. Thus, Utility A is in a position to purchase the necessary enrichment services in the open market.

A second utility, Utility B, has a contract with a primary supplier of enrichment services that requires Utility B to take 35,000 SWUs in excess of its current requirements, at a price of $150 per SWU, or to pay contract termination fees of $70 per SWU. Thus, Utility B is in a position to sell up to 35,000 SWUs scheduled for delivery within the year.

Nuexco matches Utility A's requirement with Utility B's excess commitment, and a transaction between the utilities is arranged at a price of $100 per SWU. At a primary market price of $150, the $100 price would provide a savings of $50 per SWU to Utility A. Utility B would take a net loss per SWU of $50, but that compares favorably with the cost of carrying unwanted enriched inventory for five years or more, or with the cost of termination.

Utility B informs the primary SWU supplier of the quantity of enriched product (10,000 kgU), the enrichment assay (3.0 w/o), the tails assay (0.3 w/o), and the desired delivery date, in accordance with the primary enricher's advance notice period. Utility B also delivers 65,690 kgU of natural UF_6 to the primary enricher in accordance with the normal feed delivery schedule.

On the date of product delivery, Utility B transfers to Utility A's account with the primary enricher the 10,000 kgU of enriched product. Utility A wires a cash sum of $3,424,000 to Utility B, and transfers 65,690 kgU of natural UF_6 to Utility B's account at a conversion or enrichment facility. Within thirty days after delivery of the enriched product, Utility B pays $5,136,000 to the primary enricher. This hypothetical transaction is illustrated in Figure 1.

Variation of Tails Assay

If Utility A evaluated the transaction on the basis of a lower tails assay, the number of SWUs involved in the transaction would increase, while the necessary amount of feed would decrease. For any tails assay in the range allowed by the primary enricher, there is a unique combination of feed and SWU quantities that will produce the same quantity of enriched product. Thus, for example, if the transaction had been based on a tails assay of 0.2 w/o rather than 0.3 w/o, 43,060 SWUs and 54,790 kgU of natural UF_6 feed would have been necessary to generate the same 10,000 kgU enriched to 3.0 w/o U_{235}. The effect on the transaction of this variation in tails assay is illustrated in Figure 2.

A more complicated variation of tails assay is illustrated in Figure 3. In this case, the contract with the primary SWU supplier is based on a 0.3 w/o tails assay, and the agreement between Utility A and Utility B is based on a 0.2 w/o tails assay. Note that Utility B's net cash loss is relatively smaller, but is compensated for by a net loss of feed. The situation could be reversed if Utility A requested a 0.3 w/o tails assay and Utility B was obliged to take a 0.2 w/o tails assay from the primary supplier. In that case, Utility B's net cash loss would be relatively greater, but would be compensated for by a net gain of feed.

Figure 1

HYPOTHETICAL DEENRICHMENT SWAP
(Using tails assay of 0.3 w/o)

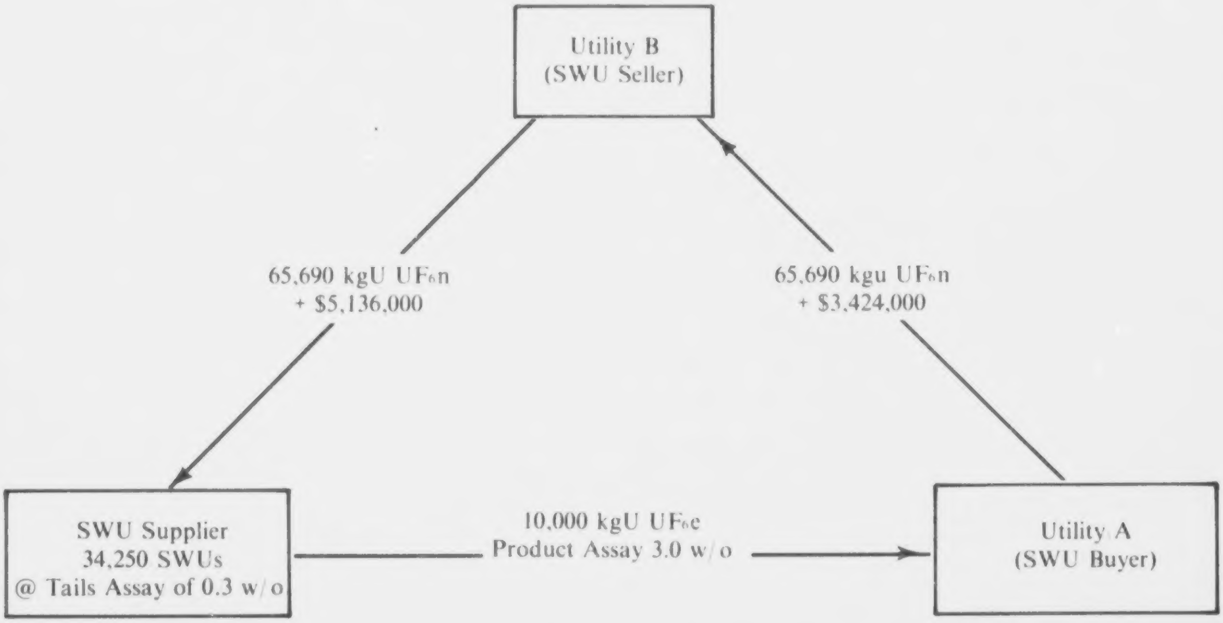

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Figure 2

HYPOTHETICAL DEENRICHMENT SWAP
(Using tails assay of 0.2 w/o)

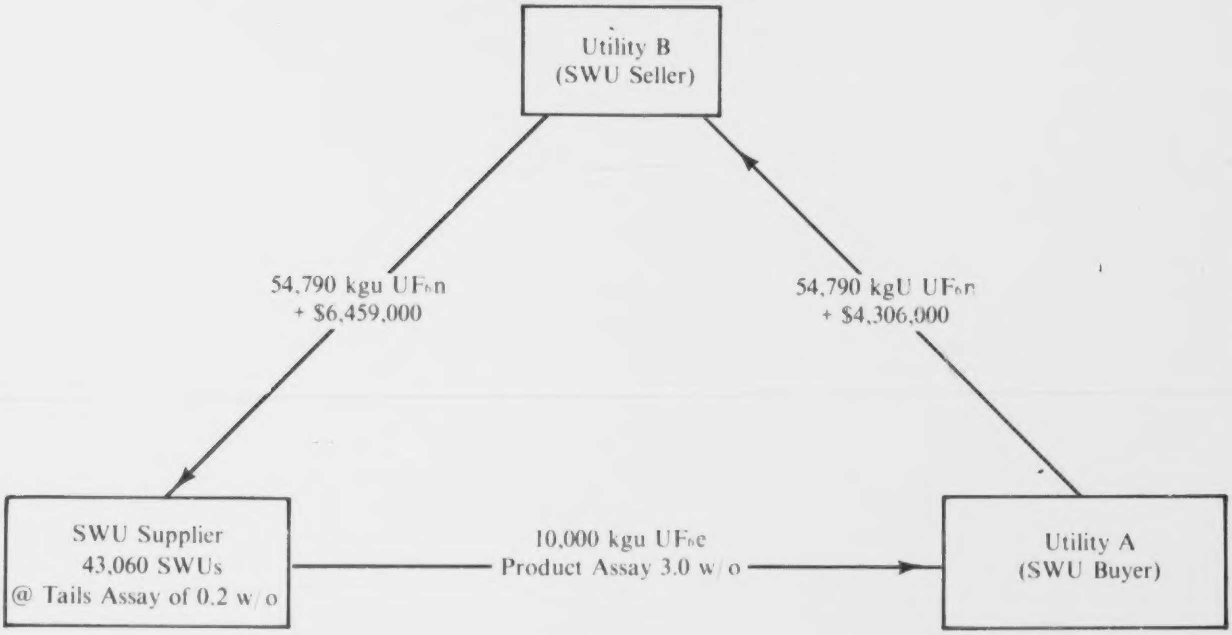
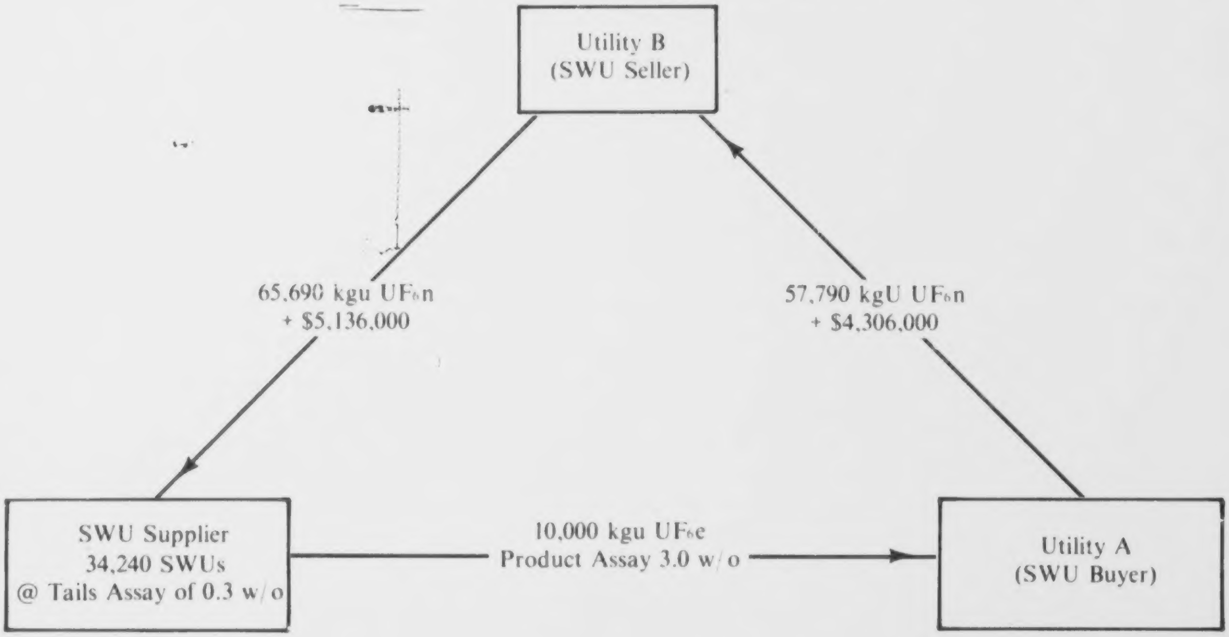

Utility B
(SWU Seller)
54,790 kgu UF_6n
+ $6,459,000
54,790 kgU UF_6n
+ $4,306,000
SWU Supplier
43,060 SWUs
@ Tails Assay of 0.2 w/o
10,000 kgu UF_6e
Product Assay 3.0 w/o
Utility A
(SWU Buyer)

Figure 3

HYPOTHETICAL DEENRICHMENT SWAP
(Using combined tails assays of 0.2 and 0.3 w/o)


Utility B
(SWU Seller)
65,690 kgu UF_6n
+ $5,136,000
57,790 kgU UF_6n
+ $4,306,000
SWU Supplier
34,240 SWUs
@ Tails Assay of 0.3 w/o
10,000 kgu UF_6e
Product Assay 3.0 w/o
Utility A
(SWU Buyer)

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Other Transaction Types

Other than the deenrichment swap, the most common types of secondary market SWU transaction are the contract assignment and the enriched product sale. In an *enriched product sale*, an owner of enriched product sells the entire commodity to a buyer for cash or other considerations. The price paid by the buyer reflects both the natural uranium and the SWU components of the product. An enriched product sale may be attractive to a holder of a large unwanted inventory of enriched UF_6, if that holder is not interested in retaining the natural uranium component of the product. Such a transaction may be attractive to a buyer if the buyer lacks both natural uranium and enrichment services, and has the financing to pay for the entire product at once.

In a *contract assignment*, a seller that has an unwanted contract obligation to take enrichment services from a primary SWU supplier pays a buyer to assume all or part of that contract obligation. Commonly, the amount of the payment by the seller is expressed as a discount off the primary SWU price. Thus, if Utility C assigns 10,000 SWUs to Utility D at a discount of $10, Utility C will pay Utility D $100,000, and Utility D will assume the obligation to pay the primary SWU supplier.

Payment from the assignor (Utility C) to the assignee (Utility D) can be made in any of several ways, each of which has essentially the same effect.

1. In the preferred method, the assignor transfers to the assignee all or part of the prepayment credits paid earlier to the primary SWU supplier. This method's use of funds already paid to the primary supplier is free of risk to the assignee, but more importantly, it allows the assignor to use funds already expended, rather than using new funds.
2. In other methods, the assignor pays the funds directly to the assignee. The payment may take place on delivery of the SWUs, in which case the assignee takes the risk that the assignor might not be able to pay at the appointed time.
3. When the assignor pays the discount to the assignee upon signing the contract for SWU assignment, the discount may be adjusted downward to reflect the time value of money associated with the time interval between contract signing (payment date) and the date the assignee withdraws the SWUs from the primary enricher.

Generally, a contract assignment may be made only with the consent of the primary enrichment supplier. That feature is the most important way in which assignments differ from sales and swaps. Assignments differ from sales and swaps in two other related ways.

1. A deenrichment swap caters to the hard cash needs of a seller, while an assignment caters to the cash needs of a buyer. The financially weaker party is normally the price leader in the transaction.
2. A deenrichment swap involves relatively more work by the seller, while an assignment involves relatively more work for the buyer. "Relatively more work" includes, at the very least, the responsibility for doing business with the primary enricher. That responsibility may be considered undesirable, particularly if the primary enricher seeks to hinder activity in the secondary SWU market.

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URANIUM ENRICHMENT IN JAPAN

Introduction

Japan has come to rely heavily on offshore suppliers for enrichment services: 24 LWRs requiring enriched uranium are now in commercial operation; 23 more are in the planning, licensing or construction stages. For more than a decade the government has promoted a domestic enrichment program with the goal of providing Japan some degree of fuel self-sufficiency. Government-sponsored Power Reactor and Nuclear Fuel Development Corporation (PNC) has demonstrated the technology required for commercial-scale centrifuge facilities. Recently a preliminary site for a commercial plant was defined, and the government has urged the utilities to coordinate development plans. However, because of the large and economical supply of enrichment services in the world market, the utilities may hesitate to commit resources to a commercial plant for several years.

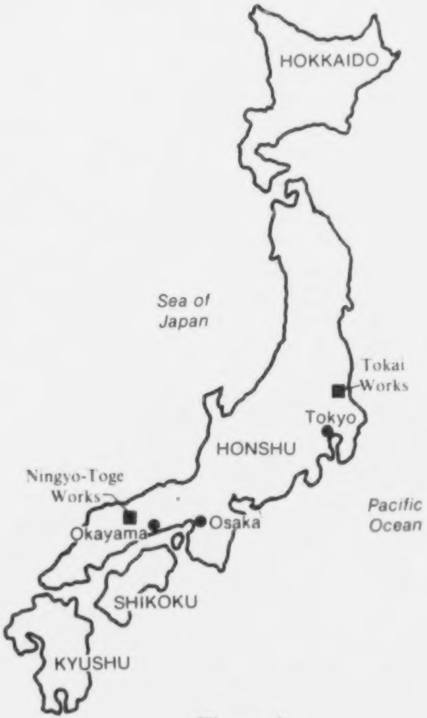

Figure 4

LOCATION OF ENRICHMENT FACILITIES IN JAPAN

PNC Centrifuge Program

In the late 1950s, a government-sponsored company known as Atomic Fuel Corporation began research on uranium enrichment processes. In 1964 the company fabricated and tested Japan's first enrichment centrifuge machine. In 1967 the government (with some support from private industry) established PNC to undertake research and development on advanced reactors and fuel technologies. PNC absorbed the staff and programs of Atomic Fuel Corporation at that time. In 1972, following a three-year evaluation of alternate enrichment technologies, Japan's Atomic Energy Commission (AEC) directed PNC to commence a major research and development effort on centrifuge enrichment.

By 1974 PNC successfully fabricated and installed at its Tokai works, north of Tokyo, an initial cascade having 180 centrifuge machines. A second, 250-machine cascade was completed in 1975. Those two cascades tested SWU output and machine performance under both normal and abnormal operating conditions.

Pilot Plant

In 1976 the AEC authorized PNC to build a pilot plant at PNC's Ningyo-Toge Works in western Japan (Figure 4). Construction on the first phase of the pilot plant, designated OP-1, began in 1977. Approximately 1000 machines (referred to as OP-1A machines) were completed in September 1979, while approximately 3000 more (OP-1B machines) were completed in October of that year. The 4000 OP-1 machines achieved full operation in October

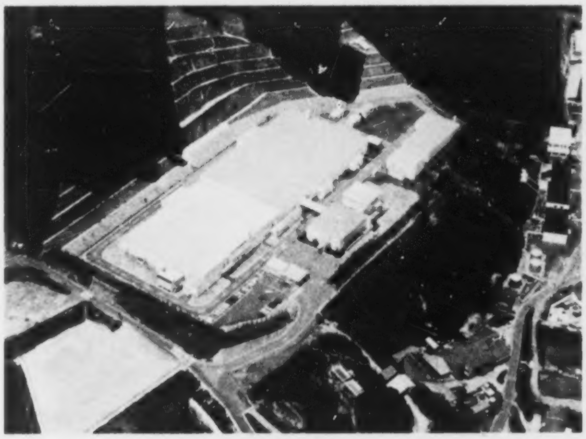

Figure 5. Aerial view of uranium enrichment pilot plant, Ningyo-Toge.

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1980. PNC made the first enriched UF_6 shipment from the Ningyo-Toge pilot plant in April 1981.

Construction on the second phase of the pilot plant (designated OP-2) was completed in October 1981. Continuing research and development at PNC's Tokai facility enabled PNC to incorporate into the 3000 OP-2 machines improvements to the OP-1 machine designs. The OP-2 machines achieve approximately twice the separative work output of the OP-1 machines. Also, the hardware configuration of the OP-2 machines permits a work output per unit area that is five times greater than that of the OP-1A hardware arrangement.

PNC achieved full operation of the approximately 7000 machines at the Ningyo-Toge pilot plant in March 1982. The plant produces at a rate of approximately 50,000 SWUs per year. Since December 1982, the enriched product has been used to fuel PNC's Fugen unit, a 165-MWe heavy water-moderated, light water-cooled demonstration reactor. The pilot plant's performance has exceeded PNC's most optimistic expectations. The annual machine failure rate has been below 0.2 percent, compared to a targeted rate of 1.0 percent. Figure 5 is an aerial view of the pilot plant; Figure 6 shows the control room.

Demonstration Plant

In addition to operating the 7000-machine pilot plant, PNC is continuing centrifuge and cascade development at the Tokai Works. In March 1983 the company successfully re-enriched depleted uranium recovered from its demonstration reprocessing plant at Tokai. PNC has developed centrifuge machines that have three times the SWU output of the pilot plant's OP-1A machines. A cascade of new machines will be tested for reliability later this year.

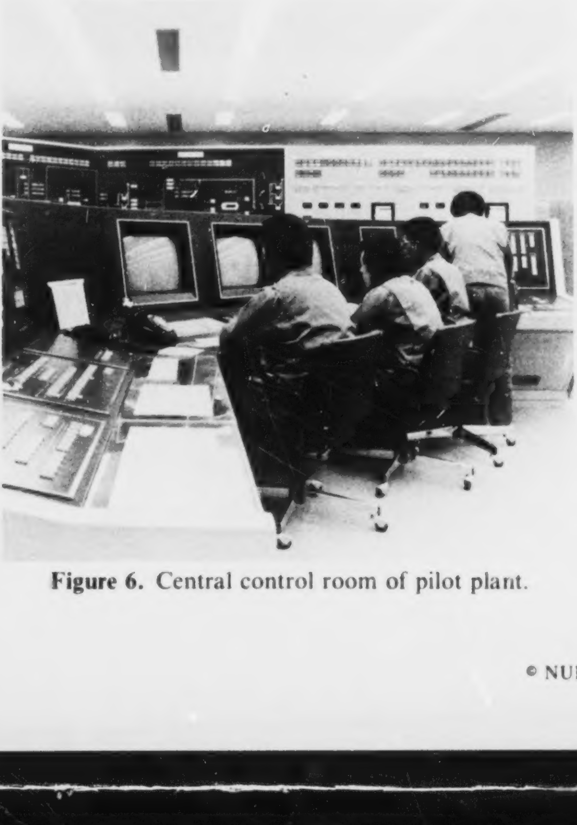

Figure 6. Central control room of pilot plant.

PNC has begun groundwork at the Ningyo-Toge Works on a demonstration enrichment plant that will have the capacity to produce 200,000 SWUs per year. The first increment of capacity (100,000 SWUs per year) is scheduled to begin operation in 1987, and full capacity operation is scheduled for 1988.

Plan for Commercial Plant

At the recommendation of the AEC, the government has urged the utilities and the associated industrial groups to take the following steps for construction of a commercial-scale enrichment plant.

1. The private utilities should finance a company to construct a facility having the capacity to produce 1 million SWUs per year by 1995. The plant should be expanded to a capacity of 3 million SWUs annually by the year 2000, and should use the technology developed by PNC.
2. The three electrical hardware makers (Toshiba, Mitsubishi Heavy Industries, and Hitachi) should organize a joint venture manufacturing company to produce the necessary machinery for the plant. (On the order of 100,000 centrifuge machines would be required for the facility.) The three hardware makers are the primary suppliers of LWRs to the utilities, and have been the primary hardware suppliers to PNC.

Realization of an enrichment plant in the time frame promoted by the government may depend on a greater degree of state participation than the government currently proposes. Thus far, the government (via PNC) has borne the primary share of the costs for the domestic enrichment program. There is little economic motivation for the utilities to make the capital expenditures necessary for a commercial plant at the present time. Inventories of enriched uranium and the supply of enrichment services worldwide greatly exceed demand; that supply is likely to remain adequate well into the next century. The arguments in favor of the government's plan, however, are in keeping with Japan's traditional conservatism regarding security of fuel supply.

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THE ROSSING PROJECT (PART 2)

Ore Body Development

Rio Tinto Management Services South Africa (Pty) Ltd. began to develop a mine plan for the Rossing uranium deposit in 1970. The initial plan was to establish a mine and mill operation having an annual capacity of 2500 tonnes U_3O_8. Rio Tinto contracted engineering and design work for a processing plant to Davy Power Gas (UK) and Western Knapp (USA) in 1971. A project feasibility study was completed by May, 1973; the decision to go ahead with the project was announced three months later.

Simultaneous with the decision-making period, uranium market opportunities began an upward trend worldwide. RTZ negotiated additional sales contracts and made the decision to increase production capacity to 5000 tonnes U_3O_8 annually. Mine and mill development plans were altered to meet that schedule. Construction began in July 1974; the first natural uranium concentrates were produced in June 1976.

The analytical results of surface drilling and underground work served as a basis for an ore reserve estimate at Rossing. Three-dimensional ore blocks were established using compatible computer technology. The minable dimension per ore block was estimated for contained tons and grade, with comparative relationship to adjacent blocks.

The three-dimensional ore blocks were factored into a mine development schedule. A computerized series of mine-life programs indicated that open pit mining over a minimum period of 20 years was the optimum operating schedule for the project. The long-term mine plan established a format for general pit development, structured to accommodate the mining process on 15-meter-high benches (working levels in the pit) with an average pit wall slope of 45 degrees.

Figure 7 illustrates the bench and mining pattern. At the end of the 20-year period, the pit will measure approximately 3 km long, at least 1 km wide, and 300m in depth (22 benches). Production of uranium is tentatively scheduled to terminate at that time; however, ore reserves are sufficient to support the program beyond 20 years.

Mine Operations

To carry out the large-scale mining operation (40,000 tonnes ore and 100,000 tonnes of waste per day), medium and short-term mine plans were coordinated into the 20-year plan. The mine now operates under the following master plan to maintain a favorable mining schedule:

1. A five-year plan guides long-range pit development, and is updated annually.
2. A one-year plan establishes the mining sequence over each 90-day period, and is updated quarterly.
3. A three-month plan, updated monthly, determines the mining sequence and average ore grade going to the mill for a 30-day period.
4. A monthly plan is updated on a weekly schedule.
5. Production is reviewed daily and projected ahead on a weekly schedule.

The mining schedule has not been maintained without related problems. One condition that is particularly troublesome is the erratic distribution of mineralization throughout the deposit. The high level of production at a satisfactory grade requires continuous drilling on a selected grid of 20m × 20m. The holes are drilled to a depth of 45m, allowing for a progressive estimate of reserves and production for the next three mine levels. The short-term mining sequence is further evaluated from the radiometric results of blast holes, which are usually drilled to a depth of 5m on a grid of 8m × 8m.

Grade control begins with the radiometric logging of each drill hole, followed by analysis of drill cuttings. The ore and waste zones are plotted accordingly, and the mine schedule is established on a medium or short-term schedule. Blasted rock is divided into four grade categories before removal from the pit begins. A grade control engineer enters the pit immediately after the blast to determine radiometrically the grade of the broken rock. A color code is used to designate high-grade ore, medium-grade ore, low-grade ore, and waste rock.

Specialized blasting techniques are applied to minimize mixing of ore-types and dilution of the ore, which is a serious potential problem. Effective grade control is practiced also by radiometric scanning of each truckload of material coming from the mine. High and low-grade ore mined together is trucked directly to the primary crusher; in the absence of high-grade ore, only medium-grade is crushed and the low-grade is stockpiled for later mixing with high-grade. Mill head grades are controlled at about 0.035 percent U_3O_8 by this procedure.

Ore Processing

The metallurgical plant at Rossing is the largest uranium processing facility in the world. It was designed to operate at 40-45,000 tonnes ore per day. Although the plant began operating in mid-1976, design capacity was not attained until early 1979 due to a number of start-up

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problems, some of which required modifications to plant design. The most serious problem was related to the abrasive nature of the uranium-bearing alaskite. The rock contains over 30 percent quartz, which causes excessive wear on machinery, primarily the crushing units and certain conveyor and piping systems. The plant experienced considerable down-time in the early months of operation as a result. A special group of engineers was assigned the urgent task of solving that problem and of improving the milling process in general. The ultimate task of the group was to improve uranium recovery, which was consistently below 80 percent at that time.

A number of design changes were implemented starting with an improved crushing process. The task was essentially accomplished by the first quarter of 1979. Daily mill run increased to 40,000 tonnes and U_3O_8 recovery improved to 85 percent. The operation has continued near those levels since.

The Rossing recovery plant utilizes an acid leach, ion exchange, and solvent extraction process. The ore is trucked from the mine directly to the primary crushing unit. The crushed material exits the unit as coarse ore at a minus 160mm (about six inches). The ore passes on to a stockpile which is maintained at 70–80,000 tonnes, a two-day ore supply to the mill. The ore is next delivered to the secondary crushing unit where it is reduced to a minus 65mm. The ore is then screened to a minus 19mm. The material falling through the screen goes directly to the fine-ore storage area. The oversized material passes through yet another crushing stage, then back to the screen, and on to fine-ore storage. The screens were added to the crushing circuit to minimize the abrasion problem downstream. The capacity of the crushing plant is 2500 tonnes per hour.

The fine ore is further reduced to a minus 1.7mm in four rod mills, each with an hourly capacity of 500 tonnes. As the ore enters the rod mill, water is added to maintain a pulp density of 76 percent solids. The water is preheated to 45 degrees C to enhance leaching conditions. The main uranium mineral present is uraninite, which occurs as grains up to 0.3mm in size. It is liberated during the grinding phase and is readily exposed to the leach lixiviant in the next milling phase. The fine ore enters by conveyor belt, and exits as slurry through overhead piping systems. Figure 8 is a view of the rod mill.

The heated pulp from the rod mills is fed directly to the acid leach circuit, which includes two parallel lines of six tanks each. The tanks are mechanically agitated, affording total particle contact with the acid lixiviant at all times. Manganese dioxide is added before the pulp enters the leach circuit to facilitate oxidization of the uranium. Sulfuric acid is added to the first and second tanks where leaching is initiated at 50 degrees C. Retention time for the leach circuit is 13 hours. About 85 percent of the contained uranium is taken into solution.

The product leaving the leach circuit contains a uranium-rich slime and suspended sand particles. The material is directed through hydrocyclones, where separation takes place. The overflow contains the slime and is sent directly to the countercurrent decantation circuit. The sand underflow is washed to remove the last traces of uranium and sent directly to the tailings disposal area.

Uranium is washed from the slime as it passes through the five decantation thickeners. The uranium-bearing solution flows from the fifth thickener to the ion exchange section. Any sand recovered from the thickeners is sent to the tailings disposal area.

The pregnant solution is pumped to the continuous ion exchange circuit, consisting of the Porter up-flow fluid bed ion exchange contractors. The upward flow of pregnant solution fluidizes the resin bed. The resin is loaded with uranium as it moves counter to the fluids. The loaded resin is transferred to a fixed-bed column system for elution with a solution containing 10 percent sulfuric acid.

The acidic eluate produced is transferred to the solvent extraction plant, where it is mixed with an organic solvent that takes up the uranium. The loaded organic solution is then mixed with an ammonium sulfate solution that absorbs the uranium, producing what is termed "OK liquor" to be sent to the recovery plant for final processing.

Additional ammonia is added to the OK liquor in the precipitation plant, and the uranium precipitates out as ammonium diuranate. The product is recovered on rotating drum filters as a yellow paste. It is then roasted to drive off the ammonia, producing a final product of uranium oxide or yellowcake, which is packed in steel drums for shipment.

Mineralogy

Uraninite is the most important primary uranium mineral present in the Rossing deposit. It makes up about 55 percent of total uranium contained in the rock. Betafite also is a primary mineral, occurring as 5 percent of contained uranium. However, it is a refractory mineral, essentially all of which is lost to recovery because it cannot be liberated by the acid leach process.

Secondary uranium minerals make up the remaining 40 percent. The main mineral is beta-uranophane, followed by metatorbernite and carnotite. The secondary minerals

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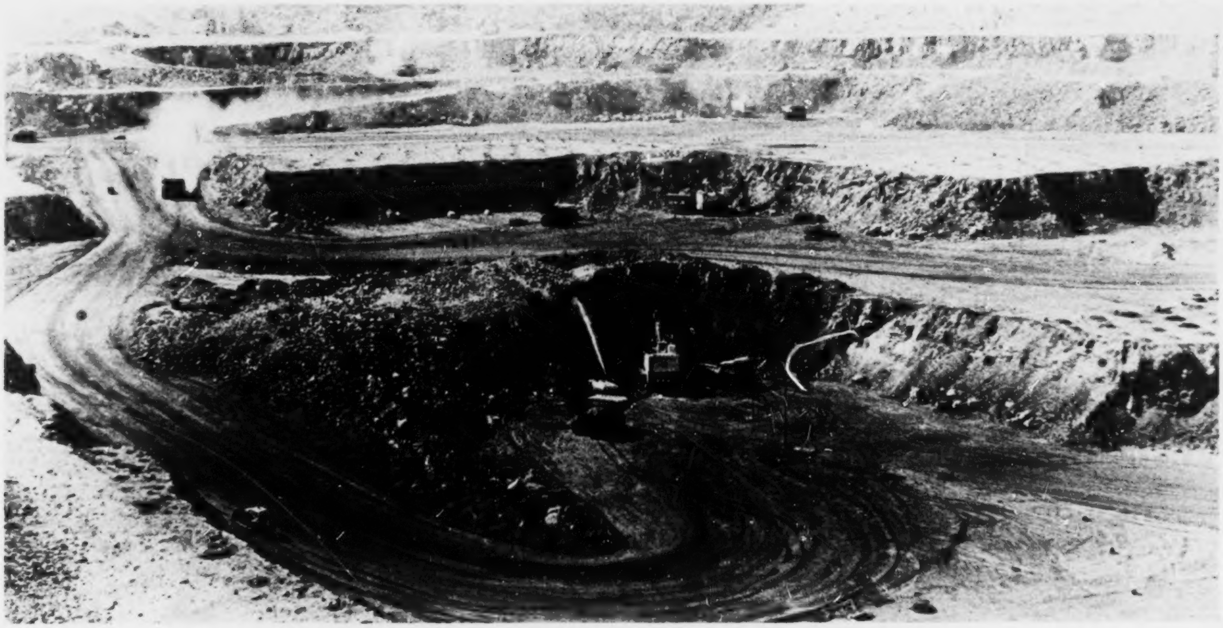

Figure 7. Bench configuration and sequential stripping and mining pattern from upper to lower benches.

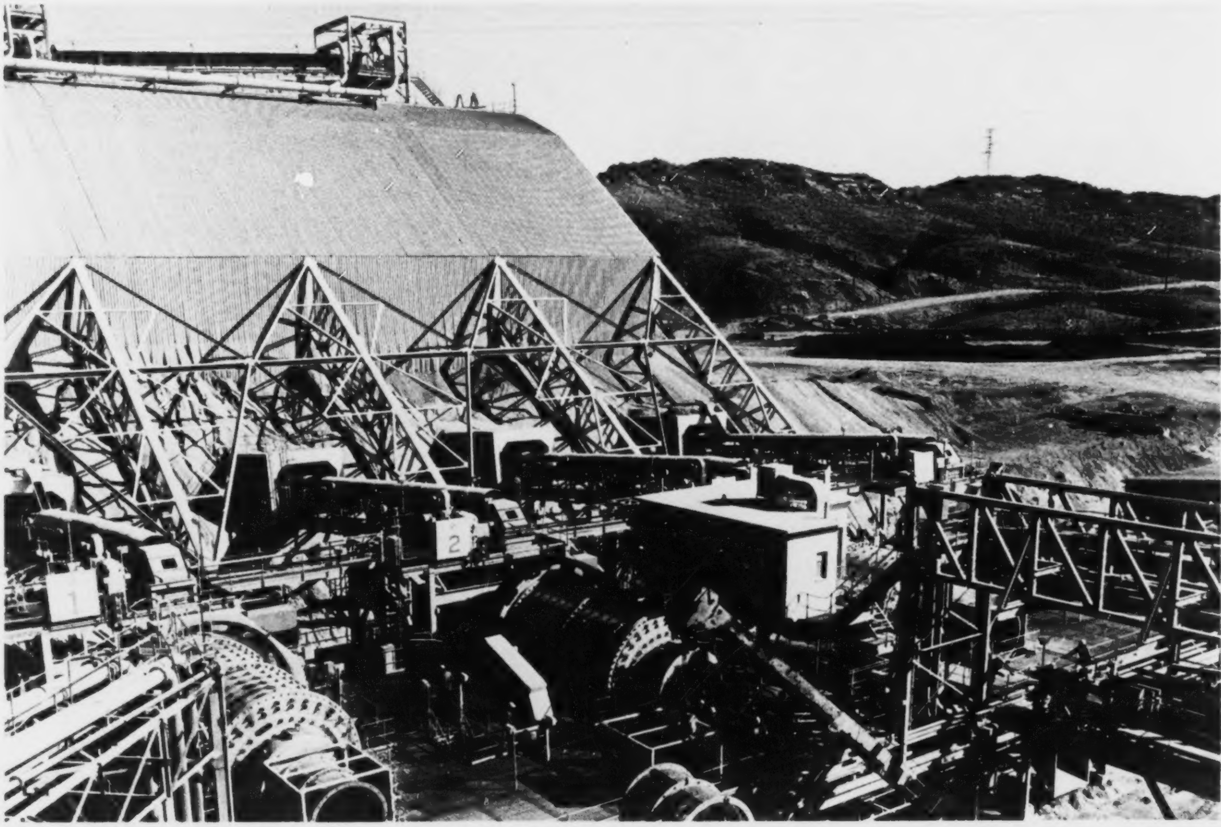

Figure 8. View of the rod mill circuit. Ore enters the rod mills from the fine-ore storage area by conveyor; it exits as a pulp to the acid leach circuit.

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usually occur as bright yellow or green minerals associated with alteration zones in the host rock.

The primary mineralization occurs in close association with concentrations of quartz, feldspar and biotite in the alaskite. In fact, the ore minerals show an affinity to biotite-rich structural features (fault and fracture zones). The secondary minerals naturally parallel the same pattern. Migration into normally barren country rock is a common occurrence, but rarely in minable quantities.

The mineralization shows zoning in the alaskite. It occurs in two different stratigraphic horizons referred to as the north ore zone and the central ore zone. The zones tend to diverge on the western side of the deposit, separated by a large block of barren hornblende gneiss. The two zones are exposed on the surface near the western end of the deposit. To the east, the zones converge and thin, assuming an almost vertical dip. The determined outline of mineralization measures approximately 3 km long and 1 km wide. Structurally, the ore deposit pitches to the southeast, becoming too deep for mining under the existing mine plan.

The origin of uranium minerals at Rossing is probably related to the implacement of the granites in the area. The primary minerals were included as an integral part of the rock-forming process. The obvious high-grade concentrations forming ore zones probably developed as a result of segregation or banding that occurred in the early stages of consolidation (cooling) of the igneous rocks. The secondary minerals may be hypogene, a product of alteration and enrichment created by ascending solutions.

Geology

The Rossing uranium deposit occurs in rocks identified with the Damaran Orogeny, the geologic age estimated between 600 and 500 million years ago. The Damaran orogenic belt extends for several hundred miles in a northeast-southwest direction through Namibia, covering most of the Namib Desert region, northward into southern Angola, and possibly as far east as Zambia.

The Damaran series is late Precambrian in age, consisting of folded and metamorphosed rocks in close association with structurally related synclines and anticlines that parallel the belt trend. Domal structures interrupt the syncline/anticline sequence, suggesting a later period of orogenic activity along the Damaran belt. Extensive intrusions of granite and pegmatite disrupt the structural pattern throughout the belt, especially in the central area around Rossing Mountain. It is within this zone of geologic environment — granitic intrusions and intense metamorphism — that the Rossing uranium deposit occurs.

The uranium-bearing alaskite granites at Rossing have intruded a highly metamorphosed section of the Khan and Rossing formations. The Khan represents the upper portion of the Nosib Formation, which is in unconformable contact with Abbabis metasediments of early Precambrian age. The Khan sequence is dominated by hornblende gneiss and biotite schist up to 250 meters thick. The Khan is broken by intrusive bodies and dikes of uraniferous alaskite, making it an important stratigraphic sequence to mining.

The Rossing Formation directly overlies the Khan Formation. It has been divided into six members, or units, of which about 120 meters of the lower four units have been influenced by intrusions of uraniferous alaskite. Transgressing upward, the basal unit consists of marble containing little mineralization. The overlying unit consists of biotite gneiss that is highly displaced by alaskite; it is one of the main mineralized units. The next unit is conglomeratic, grading from 5cm-sized quartz pebbles in the southern part of the ore deposit to coarse arkosic sand in the eastern part. Banded marble, quartzite and biotite schist make up the upper stratigraphic unit containing important uranium mineralization. The ore deposit is situated within this stratigraphic environment on the limb of a large domal/synclinal structure.

Locally, the intensity of structural events is exemplified by tightly folded and distorted rock, especially within the Rossing Formation. Faulting is common on the peripheral limits of the domal structure, with vertical and horizontal displacement up to about 50 meters. Fracturing is common in all rock types; in the alaskite, it provides a favorable environment for secondary uranium mineralization.

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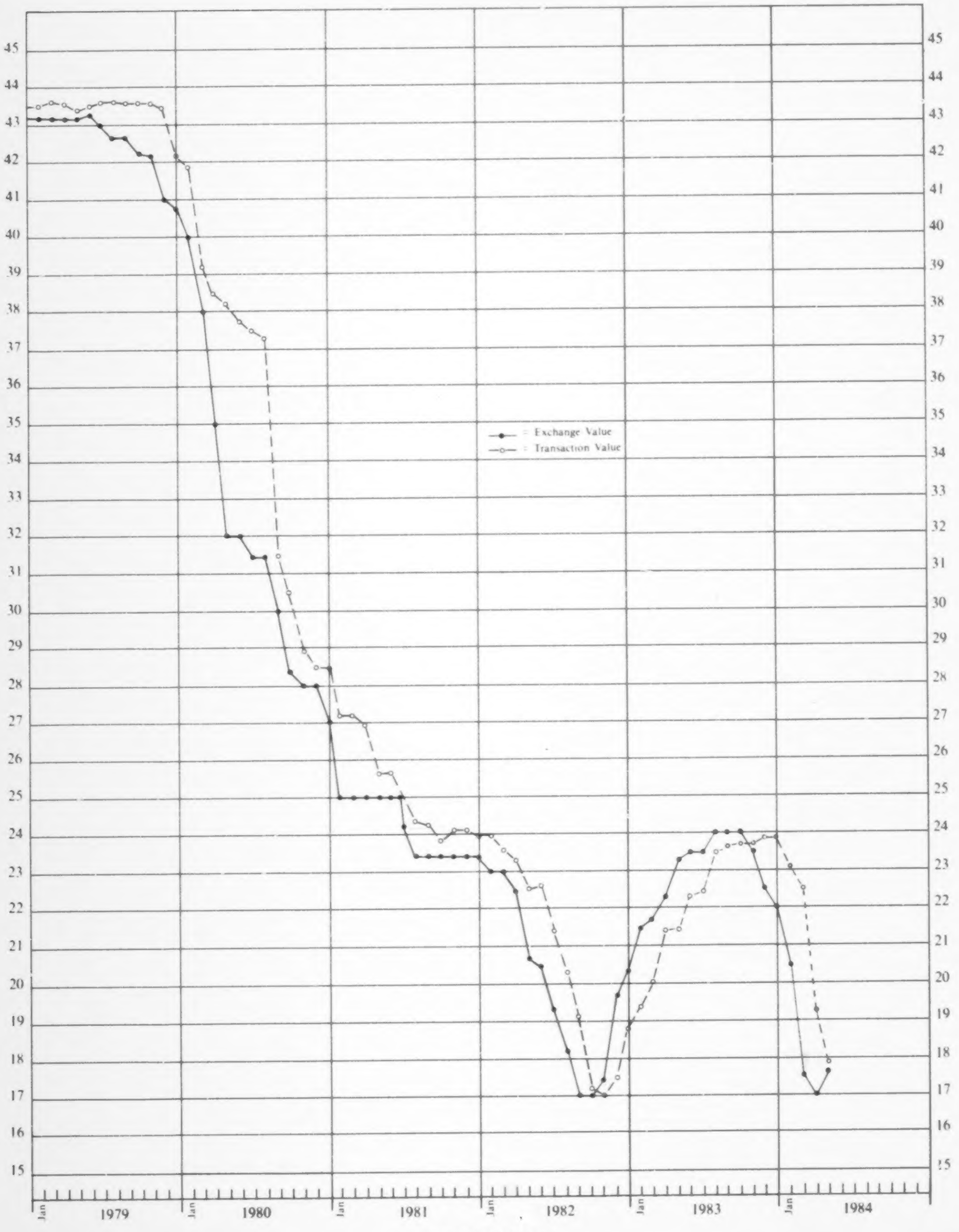
EXCHANGE AND TRANSACTION VALUES
SINCE JANUARY 1979

Determined as of the last day of the month indicated



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HISTORICAL MARKET DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	32.50	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00
1984	20.50	17.50	17.00	**17.75**								

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85
1984	23.05	22.50	19.25	**17.90**								

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60
1984	0.60	0.30	0.80	**0.80**								

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AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage Earners, Weekly Rates[2] (1976=100)
1972 Avg.	105.6	71.3
1973 Avg.	124.4	79.0
1974 Avg.	141.9	108.1
1975 Avg.	150.4	132.6
1976 Avg.	168.4	160.9
1977 Avg.	192.0	179.0
1978 Avg.[3,4]	198.5	190.0
1979 Avg.	248.8	127.9
1980 Avg.	321.8	140.8
1981 Avg.	355.3	154.1
1982 Avg.[5]	368.6	174.9
1983 Avg.	401.6P	181.8
Jan 1983	385.7	179.6
Feb 1983	387.5	179.8
Mar 1983	397.4	179.7
Apr 1983	407.6R	180.0
May 1983	415.1R	180.1
Jun 1983	415.9R	180.2
Jul 1983	408.8R	179.9
Aug 1983	403.5R	179.9
Sep 1983	403.4R	179.8
Oct 1983	398.0R	187.6
Nov 1983	396.1R	187.6
Dec 1983	399.6P	187.4
Jan 1984	—	187.6

P = Preliminary R = Revised since last month

[1] Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0).

[2] Australian Bureau of Statistics, Canberra: "Award Rates of Pay Indexes, Australia" (Catalogue No. 6312.0). Figures for the latest fourteen months shown are subject to revision.

[3] Monthly data for 1970-78 appear on pages 4.7 and 4.8 of Report 138.

[4] Annual averages prior to 1979 reflect index base no longer in use.

[5] Monthly data for 1979-82 appear on page 35 of Report 184.

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GOVERNMENT STATISTICS

CANADA

	Industry Selling Price Index: Manufacturing[1] (1971=100)	Wage-earner Data: Average Hourly Earnings (C$)[2]						
		Uranium Mines (SIC 057)	Metal Mines (SIC 051-059)	Mines, Quarries and Oil Wells[3] (SIC 051-099)	Primary Metal Industries Non-ferrous[4]			Chemicals and Chemical Products[5] (SIC 370-379)
					(SIC 296)	(SIC 296-298)	(SIC 298)	
1979 Avg.[6]	217.9	—	9.60	9.66	—	7.35	—	7.67
1980 Avg.	247.2	—	10.59	10.80	—	8.05	—	8.50
1981 Avg.	288.7	—	12.02	12.23	—	9.03	—	9.53
1982 Avg.[7]	288.8	—	13.74	13.92	—	9.98	—	10.63
1983 Avg.	298.8	—	14.69R	14.30R	—	—	—	11.17R
Jan 1983	292.7	—	14.36	14.35	—	10.72	—	11.06
Feb 1983	293.5	—	14.24	14.28	—	10.74	—	11.06
Mar 1983[8]	295.2	16.79	14.84	14.48	—	10.93	—	11.21
Apr 1983	297.1	16.83	14.40	14.13	11.57	—	10.10	11.02
May 1983	298.5	17.02	14.50	14.10	11.39	—	9.82	10.97
Jun 1983	299.3	17.02	14.60	14.07	11.33	—	9.84	11.05
Jul 1983	300.4	16.48	14.35	13.93	11.70	—	9.83	11.04
Aug 1983	301.3	16.93	14.36	13.89	11.82	—	10.08	11.19
Sep 1983	301.1	17.66	14.90	14.41	11.99	—	10.32	11.29
Oct 1983	301.6	17.73	15.27	14.65	11.76	—	10.03	11.30
Nov 1983	301.7	17.82R	15.29R	14.67R	11.78R	—	10.62R	11.38R
Dec 1983	302.7	17.84R	15.11R	14.66R	11.86R	—	10.60R	11.51R
Jan 1984	304.9	17.74	15.27	14.74	11.91	—	10.84	11.69
Feb 1984	306.3	—	15.09	14.64	11.97	—	10.88	11.57

P = Preliminary R = Revised since last month

[1] Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (Catalogue 62-011). Indexes for the most recent six months shown are subject to revision.

[2] Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours" (Catalogue 72-002).

[3] Reports 175 through 185 list this series title incorrectly as "Metal Mining, Including Milling (SIC 050-099)".

[4] Beginning with the April 1983 figure, Primary Metal Industries, non-ferrous is split into SIC 296 and SIC 298.

[5] Chemical and Chemical Products prior to April 1983 was SIC 370-379. The new series is from a new survey which includes all companies and is based on a 1970 classification. The old survey only included companies of 20 employees or more.

[6] Montnly ISPI for 1977 and 1978 appear on page 4.10 of Report 138, and monthly wage-earner data for 1973-78 appear on page 4.11 of Report 138.

[7] Monthly data for 1979-1982 appear on page 37 of Report 184. On that page, the wage earner index entitled "Metal Mining, Including Milling (SIC 050-099)" should read Total Mining (SIC 051-099)".

[8] Beginning with the April 1983 figure, Wage Earner Data are based on a census of all companies employing 200 or more wage earners, *plus* a random survey of companies employing fewer than 200 wage earners. Prior to April 1983 only companies employing fewer than 200 wage earners are included in the Wage Earner Data.

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REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100)[3]	Producer Price Index All Groups[4] (1975=100)	Total Employment in Mining and Quarrying (Code 35)[5]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[5]
1972 Avg.	8.79	113.3	63.9	623,067	443,933
1973 Avg.	10.51	124.1	72.3	684,743	572,133
1974 Avg.	13.18	138.5	85.3	674,140	761,596
1975 Avg.	16.71	157.2	100.0	639,473	1,003,617
1976 Avg.	19.30	174.7	115.1	671,240	1,212,983
1977 Avg.	23.87	194.4	130.0	712,006	1,420,670
1978 Avg.	27.14	137.2	142.7	664,571	1,537,169
1979 Avg.[6]	30.18	155.3	164.5	692,209	1,830,632
1980 Avg.[7]	35.53	176.7	192.1	714,379	2,279,615
1981 Avg.	41.89	206.5	218.3	728,506	2,820,505
1982 Avg.[8]	47.25	233.5	248.7	707,552	3,246,071
1983 Avg.	51.87	262.2	274.8	696,579	3,644,772
Jan 1983	—	249.0	264.9	688,030	289,075
Feb 1983		253.1	267.4	697,089	281,413
Mar 1983	50.35	255.9	269.1	695,976	290,586
Apr 1983	—	257.8	270.9	697,158	286,708
May 1983	—	259.7	274.1	701,712	295,701
Jun 1983	50.51	260.8	273.1	706,933	300,177
Jul 1983	—	262.5	273.7	704,202	314,566
Aug 1983	—	265.6	278.9	698,984	311,789
Sep 1983	52.92	267.3	279.4	696,435	312,264
Oct 1983	—	270.0	281.0	693,225	311,418
Nov 1983	—	271.4	281.6	688,459	317,485
Dec 1983	53.70	273.2	283.7	690,750	333,595
Jan 1984	—	274.7	283.3	—	—
Feb 1984	—	278.4	286.5	—	—
Mar 1984	—	281.9	—	—	—

---

[1] Chamber of Mines of South Africa, Johannesburg: "Analysis of Working Results," published quarterly. The tonnage-weight index of average working costs per metric ton of gold ore milled for 1983 follows. (Base: March quarter 1982 = 100). See page 16 of Report 178 for the description and calculation of index, and page 24 of Report 178 for figures for 1982.

1983:	January-March	111.2
	April-June	111.9
	July-September	117.4
	October-December	119.6

[2] Republic of South Africa Department of Statistics, Pretoria: "Government Gazette: Consumer Price Index for Urban Areas."

[3] For annual averages prior to 1978, April 1970 = 100.

[4] Previously known as the Wholesale Price Index, now the Producer Price Index. The computation remains the same.

[5] Bulletin of Statistics, Department of Statistics, Pretoria.

[6] Historical data for the Average Declared Working Costs and Consumer Price Index 1970-1979 appear on page 4.9 of Report 140.

[7] Monthly data for Codes 35 and 40, 1977-1980, appear on page 28 of Report 157.

[8] Monthly data for 1979-82 appear on page 39 of Report 184.

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GOVERNMENT STATISTICS

UNITED STATES

	Producer Price Index[1]		Consumer Price Index[2]	GNP Implicit Price Deflator[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
	Industrial Commodities (1967=100)	All Commodities (1967=100)	(1967=100)	(1972=100)	Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1972 Avg.	117.9	119.1	125.3	100.00	4.56	4.59	4.26	3.71
1973 Avg.	125.9	134.7	133.1	105.75	4.84	4.98	4.51	3.91
1974 Avg.	153.8	160.1	147.7	115.08	5.44	5.63	4.88	4.21
1975 Avg.	171.5	174.9	161.2	125.79	6.13	6.24	5.39	4.64
1976 Avg.	182.4	183.0	170.5	132.34	6.76	6.87	5.91	4.96
1977 Avg.	195.1	194.2	181.5	140.05	7.28	7.67	6.43	5.39
1978 Avg.[5]	209.4	209.3	195.4	150.42	8.23	8.56	7.02	5.82
1979 Avg.	236.5	235.6	217.4	163.42	9.27	9.50	7.60	6.32
1980 Avg.	274.8	268.8	246.8	178.64	10.26	10.63	8.30	6.94
1981 Avg.	304.1	293.4	272.4	195.51	11.55	11.98	9.12	7.62
1982 Avg.[6]	312.3	299.3	289.1	207.15	12.33	12.94	9.96	8.21
1983 Avg.	315.8	303.1	298.4	215.63	12.67	13.44	10.58	8.66
Jan 1983	313.9	299.9	293.1	—	12.63	13.33	10.34	8.53
Feb 1983	313.9	300.9	293.2	—	12.66	13.29	10.41	8.56
Mar 1983	313.5	300.6	293.4	212.83	12.48	13.35	10.39	8.60
Apr 1983	312.4	300.6	295.5	—	12.67	13.34	10.43	8.60
May 1983	313.6	301.5	297.1	—	12.55	13.62	10.50	8.60
Jun 1983	315.3	302.4	298.1	214.55	12.66	13.38	10.52	8.63
Jul 1983	316.5	303.2	299.3	—	12.68	13.56	10.58	8.69
Aug 1983	317.3	304.7	300.3	—	12.63	13.46	10.61	8.64
Sep 1983	317.1	305.3	301.8	216.44	12.71	13.47	10.69	8.75
Oct 1983	318.5	306.0	302.6	—	12.78	13.56	10.78	8.73
Nov 1983	318.3	305.5R	303.1	—	12.72	13.56	10.86	8.78
Dec 1983	318.4	306.0	303.5	218.53	12.85	13.34	10.89	8.86
Jan 1984	319.2	308.1	305.2	—	12.78R	13.39R	10.90R	8.89R
Feb 1984	320.4	308.8	306.6	—	12.85P	13.40P	10.89	8.86R
Mar 1984	321.9	311.1	307.3	220.73	—	—	10.89P	8.87P

P = Preliminary   R = Revised since last month

[1] US Bureau of Labor Statistics, Washington, D.C.: "Producer Prices and Price Indexes," (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

[2] US Bureau of Labor Statistics, Washington, D.C.: Consumer Price Index for All Urban Consumers, US City Average, All Items.

[3] US Department of Commerce, Washington, D.C.: Bureau of Economic Analysis, National Income and Wealth Division: "Survey of Current Business." The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

[4] US Bureau of Labor Statistics, Washington, D.C.: "Employment and Earnings." 2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for 1977-1978 are adjusted to the March 1979 benchmark. Data for January 1979 and beyond are adjusted to the March 1980 benchmark.

[5] Monthly data 1970-1978 for Producer Price Index-Industrial Commodities, Consumer Price Index, and Employment and Earnings SIC codes 10, 333, and 28, and quarterly data for GNP Implicit Price Deflator appear on pages 4.6-4.8 of Report 139.
Monthly data 1977-1978 for Employment and Earnings SIC Codes 10, 333, and 28 appear on page 33 of Report 147.
Monthly data 1970-1978 for Employment and Earnings SIC Code 36 appear on page 23 of Report 154.
Monthly data 1977-1980 for Producer Price Index-All Commodities, appear on page 21 of Nuexco Report 158.

[6] Monthly data 1979-1982 for all listed indices appear on page 41 of Report 184.

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offers a comprehensive report on

ENRICHMENT SERVICES

◆

A WORLD MARKET STUDY
AND PRICE FORECAST
1984 to 1997

During the past two years the enrichment services market has undergone unprecedented changes as secondary markets have developed for DOE and non-DOE SWUs. When Europeans began selling aggressively in the United States market, enormous discounts appeared and DOE began to lose its share of the market. DOE responded with two Interim Sales Contracts in mid-1983 and finally with the new Utility Services Enrichment Contract in early 1984. European sellers have responded to DOE competitively.

Utility fuel managers who previously had little choice other than DOE now encounter a wide variety of options. Their choices will have a major impact on fuel costs. Potential savings can exceed tens of millions of dollars.

Nuexco has just completed an exhaustive study of the enrichment market. It is designed for the use of utility nuclear fuel managers in understanding international forces and price trends in the enrichment market. Nuexco's enrichment market study can help fuel managers fulfill their expanded responsibilities in the evaluation of rewards and risks associated with alternative SWU procurement decisions.

The report analyzes and discusses the principal factors affecting enrichment

- Consumption
- Commitments
- Unfilled Requirements
- Production Capacity
- Production Costs
- Primary Supply
- Secondary Supply
- Inventories

These results are then synthesized into four SWU price forecasts: Two for the primary suppliers (price leaders and followers) and two for the secondary markets (DOE and non-DOE).

The offer includes the current comprehensive report plus one day of consultation at the client's offices to discuss report results and applications.

To order the report or for further information, please contact:

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EXECUTIVE SUMMARY
REPORT 190
(All data as of May 31, 1984)

Exchange Value **\$17.75, unchanged**	The **Exchange Value** is **\$17.75** per pound U_3O_8, unchanged since last month. Nine recent transactions are listed in this Report, all involving deliveries prior to 1986.
Supply-Demand Ratio **unchanged at 2.2:1**	Active spot and near-term **uranium supply** amounts to **5.2 million** pounds U_3O_8 equivalent, down 2.2 million pounds from last month. Active spot and near-term **uranium demand** totals **2.4 million** pounds, down 1.0 million pounds. The spot and near-term **supply-demand ratio** remained at **2.2:1.**
Transaction Value **fell \$0.90, to \$17.00**	The **Transaction Value** is **\$17.00** per pound U_3O_8, down \$0.90 since last month. It includes 17 transactions involving a total of 3.8 million pounds U_3O_8 and equivalent UF_6 and covers a period of 3 months.
Loan Use Charge Rate **unchanged at 6%**	The **Loan Use Charge Rate** remains **6 percent** per annum.
Conversion Value **unchanged at \$0.80**	The **Conversion Value** is **\$0.80** per pound U as UF_6, unchanged since last month. One secondary market conversion transaction is reported, involving approximately 650 thousand pounds U as UF_6. Active secondary market supply of conversion services for delivery within three years totals 2.9 million pounds U as UF_6; no active demand is reported.
SWU Values **\$105 for DOE-origin (FY85)** **\$80 for non-DOE origin** **(delivery within 15 months)**	The **SWU Values** are **\$105** per SWU of DOE origin and FY85 delivery, unchanged since last month, and **\$80** per SWU of non-DOE origin, also unchanged. Five SWU transactions are reported, involving a total of approximately 750 thousand SWUs. Active secondary market SWU supply amounts to 1.2 million SWUs, while active demand totals 1.0 million SWUs.
Australia	The ASTEC inquiry commissioned by the Labor government has been completed. Its results support recent statements by senior officials advocating greater participation by Australia in the nuclear fuel market.
Canada	Key Lake produced nearly 900,000 pounds U_3O_8 in April, and should produce near capacity during the second half of this year. Ontario Hydro has begun preparatory work to replace pressure tubes in Pickering units 1 and 2.
People's Republic of China	Recent agreements between the PRC and Western governments provide the basis for trade in nuclear-related goods and services. The extent to which trade actually develops depends on a number of forthcoming policy decisions by the Chinese government.
United States	The longstanding dispute between United Nuclear Corporation and General Atomic Company over uranium contracts was settled. However, UNC may face further litigation for unilaterally abrogating a large uranium contract earlier this year.
Focus	Finland's nuclear power program has been quite successful. The utilities involved have used a combination of Soviet and Western supplies for their plants.
Amplification	An article on the nuclear power and uranium industries in France that appeared in the March Report is updated and revised this month.

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NUEXCO REPORT 190 FIGURES OF THE MONTH (May 31, 1984)	This Month (Report 190)	Last Month (Report 189)	12 Months Ago (Report 178)
Exchange Value[1]	17.75	17.75	23.50
Transaction Value[1]	17.00	17.90	22.35
Conversion Value[2]	0.80	0.80	1.20
Loan Use Charge Rate[3]	6%	6%	6%
Near-Term Uranium Supply[4]	5.2	7.4	5.9
Near-Term Uranium Demand[5]	2.4	3.4	3.1
Near-Term Supply-Demand Ratio	2.2	2.2	1.9
Recent Uranium Sales:			
Number of Transactions[6]	9	0*	8
Quantity of Material[7]	3.5	—	0.4-1.2
Nuexco SWU Values:[8]			
DOE origin, FY85 delivery	105	105	—
non-DOE origin, delivery within 15 months	80	80	—
USDOE SWU Prices:			
USEC	135.00	135.00	—
AFC	153.00[9]	153.00[9]	138.65
Requirements	157.00[9]	157.00[9]	149.85
Market Value of Enriched UF_6[10, 11]:			
2.5 w/o U_{235}	555.72	555.72	619.44
3.0 w/o U_{235}	715.89	715.89	792.80
3.5 w/o U_{235}	879.36	879.36	969.24
4.0 w/o U_{235}	1,045.09	1,045.09	1,147.96

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*Three transactions from late 1983 were reported.

[1] US $ per pound U_3O_8 equivalent.

[2] US $ per pound U as UF_6.

[3] Per annum.

[4] Active inquiries to sell, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[5] Active inquiries to purchase, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[6] Uranium sales only; does not include loans, conversion, or SWU transactions.

[7] Millions of pounds U_3O_8, equivalent.

[8] US $ per SWU.

[9] Effective 10/1/84.

[10] Calculated using the Nuexco Exchange Value, Conversion Value, and 0.20 percent tails assay. From 2/28/83 through 9/30/83, calculations used the Nuexco SWU Value for the relevant fiscal year. From 10/31/83 through 2/29/84, calculations used the Nuexco SWU Value for DOE origin and FY84 delivery. As of 3/31/84, calculations use the Nuexco SWU Value for DOE origin and FY85 delivery.

[11] US $ per KgU as UF_6.

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NUEXCO

JUNE 1984 NUMBER 190

Monthly Report on the Nuclear Fuel Market

NUEXCO

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NUEXCO

MONTHLY REPORT ON THE NUCLEAR FUEL MARKET

June 1984 No. 190

R. WESLEY MILLER, *EDITOR* JAMES J. LIGHTNER, *ASSOCIATE EDITOR*

PRICING

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NATURAL URANIUM AND CONVERSION

The **Exchange Value** as of May 31, 1984 is **$17.75** per pound U_3O_8, unchanged since last month. The *Current Market Data* section of this Report lists nine uranium sales transactions, involving a total of approximately 3.5 million pounds U_3O_8 *equivalent*. All nine involve deliveries prior to 1986.

Active supply of uranium (U_3O_8 and UF_6) for spot and near-term delivery totals **5.2 million** pounds U_3O_8 or equivalent UF_6, down 2.2 million pounds since last month. The corresponding figure for **active demand** is **2.4 million** pounds, down 1.0 million pounds. The spot and near-term **supply-demand ratio** remains 2.2:1.

The **Transaction Value** as of May 31, 1984 is **$17.00** per pound U_3O_8, down $0.90 since last month. The current Transaction Value includes 17 transactions involving a total of 3.8 million pounds U_3O_8 or equivalent UF_6 and covers a period of 3 months.

The **Loan Use Charge Rate** as of May 31, 1984 is **6 percent** per annum, unchanged since last month. No uranium loans are reported.

* * *

The market for natural uranium was somewhat more active in May than in April. While some sellers continued to await a significant rise in prices, a number chose to conclude business at current prices rather than wait and hope for improved market conditions. As has been the case for several months, the most active sellers were holders of natural UF_6, while less competitive offers came from high-cost producers and other sellers of concentrates.

The near-term supply of natural uranium dropped by 2.2 million pounds U_3O_8 equivalent during May, largely as a result of recent sales from natural UF_6 inventories. Currently more than half of active supply is made up of natural or enriched UF_6 held by two sellers. Approximately half of the current near-term demand comes from discretionary buyers interested in prices similar to those paid during March, while the other half is firm utility demand for which sellers are likely to compete vigorously over the coming weeks.

* * *

The **Conversion Value** is unchanged at **$0.80** per pound U in UF_6. One secondary market conversion transaction is reported, involving approximately 650 thousand pounds U in UF_6; that transaction had been pending for several months. Another conversion transaction involving a primary market seller was concluded during May at a price competitive with prices available in the secondary market. It was the first conversion transaction of which Nuexco is aware in which a primary supplier had in effect competed with secondary market prices. That trend has been characteristic of the *enrichment* market for several months.

The Conversion Value of $0.80 continues to represent the approximate level of sellers' offering prices. Nuexco is not aware of any active demand for secondary market conversion services; it is for that reason that sellers of natural UF_6 are making offers that assign zero or less value to the conversion component of their material. By matching or undercutting offers from sellers of concentrates, natural UF_6 sellers are able to attract the interest of buyers desiring U_3O_8 for use as feed for primary conversion commitments.

SECONDARY MARKET ENRICHMENT SERVICES

The secondary market **SWU Values** as of May 31, 1984 are unchanged since last month: **$105** for **DOE origin** and **FY85 delivery; $80** for **non-DOE origin** and delivery within approximately 15 months. The *Current Market Data* section of this Report lists five secondary market SWU sales involving a total of 750 thousand SWUs. Two of the reported transactions were sales of enriched UF_6. Active secondary market supply of enrichment services totals approximately 1.2 million SWUs, down 500 thousand SWUs, while active demand amounts to 1.0 million SWUs, up 400 thousand SWUs. The drop in supply is attributable mainly to the completion of sales by one major inventory holder, while the rise in demand is attributable to a few utilities that are likely to sign the USEC.

Despite a substantial drop in the ratio of SWU supply to demand, most utilities, including the Requirements contract holders that comprise most of the demand for DOE origin SWUs, are still assessing enrichment alternatives. The gap between DOE origin and non-DOE origin SWU prices continues to cause hesitation among utilities considering conversion to the USEC.

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CURRENT MARKET DATA

May 31, 1984	Market Values	Active Supply[1] (thousands)	Active Demand[1] (thousands)
EXCHANGE VALUE	**$17.75**/lb. U_3O_8	5,225	2,395
CONVERSION VALUE	**$0.80**/lb. U in UF_6	2,930	0
SWU VALUES			
DOE origin, FY85 delivery	**$105**/SWU	1,185	1,040
non-DOE origin, delivery within 15 months	**$80**/SWU		
LOAN USE CHARGE RATE	**6%**/annum	7,045	750

TRANSACTION VALUE

$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
17.00	3.8	17	3

[1] Supply and demand tables in the *Current Market Data* section of this Report detail the numbers for each category. Quantities of SWUs (Separative Work Units) are not referenced to a particular origin.

DEFINITIONS

1. The **Exchange Value** is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.
2. The **Conversion Value** is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.
3. The **SWU Values** represent Nuexco's judgment of the price at which transactions for the sale of significant quantities of SWUs of stated origin for delivery in the specified time period could be concluded as of the date indicated.
4. The **Loan Use Charge Rate** is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.
5. The **Transaction Value** is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:
   a. Transactions closed within the previous three-month period for which delivery is scheduled within one year of the transaction date;
   b. At least ten transactions;
   c. Transactions involving a sum total of at least 2 million pounds U_3O_8 equivalent.

   The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars using conversion rates in effect on or near the transaction date.

DERIVATIONS AND COMMENTS

1. All Market Values are based on:
   a. Data from recently completed transactions.
   b. Data from pending transactions.
   c. Firm bids to buy or borrow, and firm offers to sell or lend.
   d. Prices purchasers or rates borrowers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy or borrow, and prices sellers or rates lenders have expressed a willingness to offer, but for which Nuexco is not aware of firm offers to sell or lend.
2. Prices associated with deliveries under old or renegotiated contracts or other than arm's-length transactions are not considered in the determination of these Market Values.
3. In the determination of the Conversion Value, Nuexco does not consider transportation charges other than those customarily provided by primary suppliers of conversion services.
4. The prices of conversion services or SWUs delivered under long-term contracts with primary suppliers are not considered in the determination of either the Conversion Value or SWU Value.
5. For the SWU Values, Nuexco converts SWU prices at varying tails and product assays to equivalent SWU prices at the DOE Reference Transaction Tails Assay (presently 0.20 weight-percent U_{235}) and a product assay of 3.0 weight-percent U_{235}, assuming feed costs corresponding to Nuexco's Exchange and Conversion Values determined as of the same date.
6. In calculating the Transaction Value, Nuexco does not account for the price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of future Exchange Values or any other indeterminant variable. Also excluded from the calculation are any other transactions in which the delivery price is defined in such a way that it cannot currently be determined

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CURRENT MARKET DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
Country (currency)	**This Month (May 31, 1984)**	**Last Month (Apr. 30, 1984)**	**12 Months Ago (May 31, 1983)**	**This Month (May 31, 1984)**	**Last Month (Apr. 30, 1984)**	**12 Months Ago (May 31, 1983)**
Australia (dollar)	19.74	19.30	26.60	51.33	50.18	69.17
Belgium (comm. franc)	986.66	973.14	1,181	2,565	2,530	3,070
Canada (dollar)	22.97	22.73	28.90	59.72	59.10	75.13
Finland (markka)	102.84	101.66	128.63	267.36	264.30	334.40
France (franc)	148.91	147.43	176.96	387.13	383.27	460.05
FRG (mark)	48.51	48.01	59.02	126.12	124.82	153.43
Italy (lira)	29,963	29,697	35,075	77,897	77,206	91,186
Japan (yen)	4,107	4,020	5,589	10,677	10,452	14,529
Netherlands (guilder)	54.72	54.12	66.44	142.25	140.69	172.73
South Africa (rand)	22.73	22.12	25.28	59.09	57.50	65.71
Spain (peseta)	2,726	2,696	3,264	7,087	7,010	8,485
Sweden (krona)	143.49	141.21	176.69	373.05	367.11	459.36
Switzerland (franc)	40.12	39.64	48.88	104.31	103.05	127.07
UK (pound)	12.81	12.66	14.65	33.29	32.90	38.08
US (dollar)	17.75	17.75	23.50	46.15	46.15	61.09

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
Country (currency)	**This Month (May 31, 1984)**	**Last Month (Apr. 30, 1984)**	**12 Months Ago (May 31, 1983)**	**This Month (May 31, 1984)**	**Last Month (Apr. 30, 1984)**	**12 Months Ago (May 31, 1983)**
Australia (dollar)	18.91	19.46	25.30	49.16	50.60	65.78
Belgium (comm. franc)	944.97	981.36	1,123	2,457	2,551	2,920
Canada (dollar)	22.00	22.93	27.48	57.20	59.60	71.45
Finland (markka)	98.49	102.52	122.33	256.06	266.53	318.04
France (franc)	142.62	148.67	168.30	370.77	386.51	437.54
FRG (mark)	46.46	48.42	56.13	120.79	125.87	145.92
Italy (lira)	28,697	29,948	33,358	74,605	77,858	86,724
Japan (yen)	3,933	4,054	5,315	10,226	10,540	13,818
Netherlands (guilder)	52.40	54.57	63.19	136.24	141.88	164.28
South Africa (rand)	21.77	22.31	24.04	56.59	57.99	62.50
Spain (peseta)	2,611	2,719	3,104	6,788	7,069	8,070
Sweden (krona)	137.43	142.40	168.05	357.29	370.21	436.88
Switzerland (franc)	38.43	39.97	46.49	99.90	103.92	120.85
UK (pound)	12.27	12.76	13.93	31.89	33.18	36.21
US (dollar)	17.00	17.90	22.35	44.20	46.54	58.11

[1] Calculated using currency exchange rates published in the *Wall Street Journal* on May 31, 1984.

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CURRENT MARKET DATA

CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U as UF_6			per kg. U as UF_6		
	This Month (May 31, 1984)	Last Month (Apr. 30, 1984)	12 Months Ago (May 31, 1983)	This Month (May 31, 1984)	Last Month (Apr 30, 1984)	12 Months Ago (May 31, 1983)
Australia (dollar)	0.89	0.87	1.36	1.96	1.92	3.00
Belgium (comm. franc)	44.47	43.86	60.30	98.04	96.69	132.94
Canada (dollar)	1.04	1.02	1.48	2.28	2.26	3.25
Finland (markka)	4.64	4.58	6.57	10.22	10.10	14.48
France (franc)	6.71	6.64	9.04	14.80	14.65	19.92
FRG (mark)	2.19	2.16	3.01	4.82	4.77	6.64
Italy (lira)	1,350	1,338	1,791	2,977	2,951	3,949
Japan (yen)	185.10	181.20	285.37	408.07	399.48	629.14
Netherlands (guilder)	2.47	2.44	3.39	5.44	5.38	7.48
South Africa (rand)	1.02	1.00	1.29	2.26	2.20	2.85
Spain (peseta)	122.87	121.53	166,67	270.88	267.92	367.44
Sweden (krona)	6.47	6.36	9.02	14.26	14.03	19.89
Switzerland (franc)	1.81	1.79	2.50	3.99	3.94	5.50
UK (pound)	0.58	0.57	0.75	1.27	1.26	1.65
US (dollar)	0.80	0.80	1.20	1.76	1.76	2.65

SWU VALUES EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU FY85	Non-DOE SWU delivery within 15 months
Australia (dollar)	116.80	88.99
Belgium (comm. franc)	5,837	4,447
Canada (dollar)	135.89	103.53
Finland (markka)	608.34	463.50
France (franc)	880.87	671.14
FRG (mark)	286.96	218.64
Italy (lira)	77,245	135,044
Japan (yen)	24,294	18,510
Netherlands (guilder)	323.67	246.61
South Africa (rand)	134.44	102.43
Spain (peseta)	16,127	12,287
Sweden (krona)	848.83	646.73
Switzerland (franc)	237.34	180.83
UK (pound)	75.76	57.72
US (dollar)	105.00	80.00

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[1] Calculated using currency exchange rates published in the *Wall Street Journal* on May 31, 1984.

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CURRENT MARKET DATA

RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
2990	1984	50-100	101	unknown	US Utility	
2988	1984	301-600	97	US Entity	European Utility	UF_6. See footnote 5.
2986	1984	50-100	99	European Producer	European Broker	UF_6. See footnote 5.
2978	1984	101-300	101	Producer	US Utility	
2977	1984	101-300	104	Canadian Producer	European Entity	
2972A	1985	301-600	94	European Entity	European Utility	Enriched UF_6. Calculation assumes 0.2 tails.
2969	1985	301-600	102	European Entity	European Utility	UF_6. See footnote 5.
2816	1984	601-1,000	93	Canadian Producer	European Utility	UF_6. See footnote 5.
2813A	1984	601-1,000	see remarks	US Utility	US Utility	Fabricated fuel. Substantially discounted.

(See following page for footnotes.)

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CURRENT MARKET DATA

RECENT TRANSACTIONS[1] *(continued)*

Secondary Market Conversion Services

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U equivalent)	Approximate Price as Percent of Current C.V.	Seller	Buyer	Remarks
2672	1984-85	601-1,000	73	US Utility	European Utility	Deconversion and origin swap.

Secondary Market Enrichment Services

Nuexco Transaction Number	Delivery Period[2]	Approximate Quantity (thousands of SWUs)	Approximate Price[3] as Percent of Current SWU Value[4]	Tails Assay (Percent U_{235})	Seller Group	Buyer Group	SWU Origin	Remarks
2972B	1985	101-300	99	see remarks	European Entity	European Utility	Eurodif	Enriched UF_6. Calculation assumes 0.2 tails.
2970	1985-88	101-300	107 (see remarks)	to be determined	European Entity	European Utility	Eurodif	Refers to 1985 deliveries only.
2834	1985	50-100	84	to be determined	European Entity	European Utility	Eurodif	Amendment to existing contract.
2833	1984	50-100	unknown	unknown	US Utility	US Utility	DOE	
2813B	1984	101-300	unknown	unknown	US Utility	US Utility	DOE	Fabricated fuel.

[1] Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.
[2] Refers to calendar year, not fiscal year.
[3] Price is not normalized to 0.20% tails assay.
[4] Refers to SWU Value for same origin as SWUs included in transaction.
[5] Price calculation assumes conversion component has no value. See *Pricing* section.

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URANIUM SUPPLY
(As of 5/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale: ACTIVE			
1575	—	500 per year	
1818	—	500 per year	1985-90
2038	1,000	—	UF_6
2134	220	—	
2201	95	—	
2236	—	200 per year	1985-89
2263	—	500 per year	1985-90
2275	145	—	
2297	—	200 per year	1985-89
2335	275	—	
2336	—	250 per year	
2365	20	—	
2368	—	2,800	
2376*	200	—	
2389	300	—	
2390	100	—	
2392	35	—	UF_6
2436 A	850	—	enriched UF_6
2484	130	—	
2489*	—	500	1986-90
2505	280	—	U_3O_8 or UF_6
2509*	1,175	1,630	UF_6
2565	400	—	
TOTAL:	5,225		
INACTIVE			
0564	—	1,000 per year	1985-90
2017	1,100	1,200	
2191	125	—	UF_6
2193	—	800 per year	1986-90
2271	—	500 per year	1984-88
2326*	—	3,500	1988-91
2429	450	—	
2473	—	500 per year	1984-90
2514*	—	1,000 per year	
2553*	300	—	
2557*	570	—	UF_6
TOTAL:	2,545		

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*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

Projects removed since last month: 2483A, 2320, 2315, 2307.

CURRENT MARKET DATA

URANIUM DEMAND
(As of 5/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2217	—	1,000 per year	1988-95
2329	—	500	1985
2352	240	—	
2355 A	—	1,400	enriched UF_6
2419*	60	—	UF_6
2442*	—	250 per year	1986 on
2445	—	250 per year	1988-93
2456	650	—	UF_6
2463	260	—	UF_6
2494*	450	250	1985
2558	235	—	UF_6
2566	500	—	
TOTAL:	2,395		
INACTIVE			
1999	—	50 per year	1985-90
2244	—	350 per year	
2372	—	250 per year	1985-88
2413	—	250 per year	1986-88
2414	—	150 per year	1987-91
2457	—	650	1987
2542A*	1,400	—	enriched UF_6
TOTAL:	1,400		

*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

Projects removed since last month: 2508, 2492, 2481, 2411, 2399, 2303.

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CURRENT MARKET DATA

LOAN SUPPLY AND DEMAND
(As of 5/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Within 1 Year	Beyond 1 Year	Remarks
Available for Loan:			
ACTIVE			
1938	2,000	—	UF_6
2128*	2,500	—	
2139	2,000	—	
2483	545	—	
TOTAL:	7,045		
Inquiries to Borrow:			
ACTIVE			
2453*	250	—	
2493	500	—	
TOTAL:	750		

CONVERSION SUPPLY AND DEMAND
(As of 5/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF_6) Within 3 Years	Beyond 3 Years	Remarks
Available for Sale:			
ACTIVE			
2051	1,000	—	
2141	2,600	—	
2511	330	330	1986-90
TOTAL:	2,930		
INACTIVE			
1936	1,000	—	
2401	600	—	
2438	220	220	1985-87
TOTAL:	1,820		

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*New or revised since last month.

[1] Measured from the date of this Report.

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CURRENT MARKET DATA

SWU SUPPLY
(As of 5/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
2100	—	100 per year	1986-87
2192	100	210	1986-87
2285*	—	1,500	
2345	150	—	
2351*	—	250	1986-88
2378	130	250	1987-88
2408*	100	60	1986
2428	80	—	
2436B*	225	—	enriched UF_6
2469	—	80	1987
2510	400	—	
TOTAL:	1,185		

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*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

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SWU DEMAND
(As of 5/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2237*	—	400 per year	1987-88
2355B	—	600	enriched UF_6
2400	80	—	
2407	75	130	1986
2412	85	—	
2432A*	50	—	
2443*	150	—	
2448	20	—	
2452	30	—	1985
2454*	75	75	1986
2475	300	300 per year	1988-90
2503	—	330	1986
2518*	—	160	1987
2519*	—	30 per year	1987 on
2520*	120	—	
2522*	20	—	
2552	35	—	
TOTAL:	1,040		
INACTIVE			
2142	35	—	
2432B*	—	30 per year	1987 on
2440	—	20 per year	1988-91
2449	50	—	
2459	50	50 per year	
2471	60	40 per year	
2512	—	15 per year	1987 on
2542B*	340	—	enriched UF_6
2543*	—	25 per year	1987 on
2567	—	45 per year	1987 on
TOTAL:	535		

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* New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.
Projects removed since last month: 2491, 2346.

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RECENT DEVELOPMENTS

AUSTRALIA

At the end of May the Australian Science and Technology Council (ASTEC) submitted to the government the results of its official inquiry, entitled "Examination of the Issues Surrounding Australia's Role in the Nuclear Fuel Cycle." The government commissioned the ASTEC inquiry in November 1983 as one of the cornerstones of the Australian Labor Party's (ALP) uranium policy (see the *Annual Review* of Australia on page 18 of Report 187). That policy will be reviewed at the ALP's national conference in July, and the ASTEC report is to provide the scientific basis for debate among opposing factions of the Party.

The ASTEC Report was published on May 31, shortly before this article went to press. Nuexco has learned that the report strongly advocates a more participatory role by Australia in all aspects of the nuclear fuel cycle. It argues that greater involvement will place Australia in a better position to influence the non-proliferation of nuclear weapons, as well as the safe use of nuclear power. The report suggests that Australia consider developing domestic programs for uranium enrichment and spent fuel reprocessing in addition to expanding research on radioactive waste management.

The tone of the ASTEC report corresponds closely with recent policy pronouncements by several key ministers in the Australian government. The Minister of Resources and Energy, Mr. Walsh, proposed a draft uranium policy in March based on the premise that "Australia's ability to contribute to the reduction of the risks and hazards [associated with nuclear materials and technologies] will be enhanced if Australia continues to participate, as a uranium exporter, in the nuclear fuel cycle." The Foreign Minister, Mr. Hayden, recently stated that Australia, as a signatory to the nuclear Non-proliferation Treaty (NPT), has a moral obligation to supply uranium to nations having nuclear power programs. Australia's refusal to export counters the spirit of cooperation on which the treaty is founded, and forces purchaser nations to consider uranium suppliers that may have less concern than does Australia for the issues surrounding the nuclear fuel cycle.

In years past, and still among certain factions on the left of the ALP, the argument that Australia should be a moral leader in the uranium business had been construed negatively to mean that the nation should stay out of the business altogether. The new approach appears to be creating the most favorable climate for the Australian uranium industry in a decade. Government leaders seem to have realized the adverse economic implications of the ALP's existing policy, which includes provisions banning uranium exports to France and prohibiting the exploitation of undeveloped deposits (other than the Olympic Dam copper-uranium project).

The ban on uranium exports to France, specifically affecting an existing contract between Queensland Mines Ltd. (QML) and Electricite de France (EDF) calling for a large delivery at the end of this year, was a politically-inspired action in protest of French nuclear weapons testing in the Pacific Ocean. France, one of the world's major nuclear weapons states, has threatened to retaliate for the Australian embargo by curtailing other energy-related trade between the two nations. EDF is not dependent on the QML shipments, so the only real effect of the ban has been to jeopardize Australia's trade relations with France, and possibly other Common Market nations as well.

Thus, as the ALP prepares for its conference next month, industry observers outside Australia can expect the Party to modify its existing uranium policy along more pragmatic lines. The ASTEC report, recent policy pronouncements by senior government officials, and economic realism all suggest that policy revisions favorable to the uranium industry are imminent. The remaining *political* question is the extent to which Prime Minister Hawke and his supporters can obtain the support of the anti-uranium factions of the Party for the emergent centrist position. However, a more important *commercial* uncertainty is whether favorable political developments may be coming too late for a market that has undergone basic structural changes.

CANADA

Uranium production from Key Lake during April 1984 amounted to nearly 900,000 pounds U_3O_8, 90 percent of the project's rated monthly capacity of 1 million pounds. That level is the most yet produced at Key Lake, from which shipments started in October 1983, and could be the largest monthly quantity ever produced by a single operation. (Rossing in Namibia, which has produced on the order of 10 million pounds U_3O_8 per year, may have exceeded the 900,000 pound level in some months.) The mill was shut down for the first two weeks in May for modifications, resuming production on May 16. While other modifications will be made to the crushing circuit over the next few weeks, the operators anticipate no further interruptions in production, so output should be near capacity during the second half of the year.

The recent modifications in the mill and the ongoing modifications to the crushing and grinding circuit have been necessitated by unexpectedly high clay content in the ore. Mill throughput during the first few months of operation was well below capacity because of the clay problem. In addition, the existence of large amounts of groundwater in the project vicinity indirectly hindered the buildup to capacity. Water from the pit and surrounding wells is pumped into site reservoir number 2, which feeds the mill; the slowed rate of mill operation contributed to some overflow of the reservoir. One large spill early in January (some 27 million gallons), caused by an employee's failure to shut off a pump, received a great deal of publicity from the press. Reservoir number 2 has been back in operation since early April.

* * *

Ontario Hydro's Pickering units 1 and 2, which were shut down respectively in November and August of 1983 following the discovery of cracks in a number of pressure tubes, are undergoing preparatory work for complete retubing. The utility expects the units to resume commercial operation in 1987. The decision to proceed with retubing followed metallurgical tests indicating that as many as one-third of the zirconium-2 alloy pressure tubes in the two units could have sagged into contact with heavy-water calandria coolant channels, making them susceptible to rupturing. The existing tubes will be replaced with zirconium-nobium tubes, which are less prone to cracking.

Ontario Hydro operates nine other Candus and is building seven more; all sixteen of those units contain, or will contain, the superior type of pressure tube. After examining pressure tubes from Pickering unit 3 and one of Ontario Hydro's Bruce units, Atomic Energy of Canada Ltd. concluded that retubing of other Candus would not be necessary. However, Ontario Hydro plans to re-position garter springs, which separate pressure tubes from coolant channels, in all units that are operating or in the advanced stages of construction. The spring re-positioning is likely to delay by several months the commercial operation of the nearly-completed Bruce units 5 and 6. Another result of the Candu upgrading program will be higher electricity bills for Ontario's consumers. Replacement power from the utility's coal-fired plants costs 84 percent more than nuclear-generated electricity.

PEOPLE'S REPUBLIC OF CHINA

The government of the People's Republic of China (PRC) has concluded a number of agreements with Western governments recently that define a framework for trade in nuclear energy-related goods and services. The extent to which trade actually develops will depend on a number of forthcoming policy decisions by the Chinese government. While the government has announced a tentative nuclear generating capacity target of 10,000 MWe by the year 2000, it has not yet decided on the nature of the foreign contribution to achieve that goal.

Commercial Agreements

The most publicized nuclear trade agreement reached between the PRC and a Western government recently was that signed by Premier Zhao Ziyang and President Reagan early in May, during the US leader's state visit to the PRC. The agreement allows US companies to bid on future Chinese nuclear power projects. Under the terms of the US Atomic Energy Act, a nuclear cooperation pact must be reviewed by the US Congress for 60 days without rejection before the President can sign it into law. Because of the potential benefits for the USA of participation in the Chinese market, Congress is unlikely to reject the pact. In the near future, a high-level Chinese mission will visit the USA to continue trade discussions.

A number of US companies involved in nuclear-related businesses, including all of the major US reactor vendors and some US utilities with cancelled plants (notably the Tennessee Valley Authority and the Washington Public Power Supply Service), are actively seeking sales in the PRC. Many promoted their goods at the American Nuclear Society's nuclear technology exhibition in Beijing in mid-May. Companies in related businesses are establishing operations in the PRC as well. For example, Occidental Petroleum recently entered into a $580 million joint coal mining venture with the Chinese, and Bechtel Corporation announced a major expansion of its China operations.

The PRC has concluded nuclear trade agreements similar to the pact with the USA with the Federal Republic of Germany, France, Italy, Canada, Brazil, and Japan. Prime Minister Nakasone of Japan visited the PRC shortly before Mr. Reagan, and Japan has offered to the Chinese an attractive economic aid package totalling several hundred billion yen in loans for the development of industrial infrastructure. The Chinese have asked several Japanese companies to participate in energy development projects, including Mitsubishi Heavy Industries, C. Itoh, Niigata Electric, Nippon Steel and Nippon Electric.

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Mitsubishi (a Westinghouse licensee) recently won a pressure vessel supply contract for the PRC's first nuclear power unit, a 300-MWe PWR in the early stages of construction at Quinshan near Shanghai, in Jiangsu province. Power Reactor and Nuclear Fuel Development Corp. (PNC) is cooperating with the PRC on a three-year joint uranium exploration program.

The PRC currently is negotiating various supply contracts, primarily with General Electric of the UK, Framatome, EDF (Electricite de France) and Cogema, for the planned twin 900-MWe PWR plant to be located approximately 50 miles north of Hong Kong at Daya Bay in Guangdong province. The Daya Bay project is a joint venture of the PRC (75 percent) and a consortium of Hong Kong interests (25 percent); 70 percent of the future power from the units will be sold to Hong Kong. Thus, while the PRC is coordinating the Daya Bay project, it will not necessarily be a prototype for future Chinese nuclear power projects.

Debate Over Nuclear Power

The PRC appears to have made a firm commitment to the development of nuclear power. Coal-fired plants presently produce some 70 percent of the country's power, while hydro plants produce most of the balance. Coal is abundant in the Chinese hinterland (the PRC has the world's largest coal reserves), but costs are high to transport it to more populous regions, and the government is wary of the risks associated with dependence on long transportation lines. Furthermore, existing coal plants are not equipped with scrubbers or electrostatic precipitators, and pollution has become a serious problem in industrial centers. Most of the country's tremendous hydroelectric potential, like its coal, is located far from the regions where its use is most needed, so much goes unused.

The current government has placed strong emphasis on the modernization of the economy in order to maintain a rate of economic growth capable of sustaining China's vast population. An increasing shortage of power in the main population centers is restricting economic expansion. Construction of several new nuclear plants over the next decade and a half is a vital part of national economic strategy.

There is, however, an ongoing debate within the government over the proper mix of foreign and domestic contributions to the development of nuclear power. Traditionally, the PRC has shunned foreign investment on both ideological and economic grounds. Reluctant to make any concessions that might in any way undermine its sovereignty, the government has for the most part limited economic arrangements with foreigners to project-specific technical assistance; such practices as open bidding and turnkey performance have been rare. While the current regime's recent arrangements with Western nations reflect a new flexibility, the government has yet to decide on the proper structure for the domestic program. The Vice Premier, Li Peng, and three ministries (Water Resources and Electric Power, Nuclear Industry, and Machine Building) are involved in nuclear power policy, and all appear to have conflicting interests with regard to such issues as technology transfer, involvement of Chinese industry and personnel, and debt financing.

Officials have indicated that they are leaning toward the use of 1000-MWe PWRs for the domestic program, and the 300-MWe PWR under construction at Quinshan may act as an important training ground for the Chinese. It is not clear that the choice of reactor technology for the larger program is final, however. For several years the Ministry of Nuclear Industry has operated a number of nuclear power research institutes and experimental facilities that supplement the PRC's large nuclear weapons program. In the past, nuclear power research was particularly active in the development of heavy-water reactor technology. Research has been accelerated in recent years and expanded to include breeder technology and fusion. The Chinese could decide to use foreign assistance merely to supplement technological progress they have already achieved.

Far greater uncertainty surrounds the question of the PRC's eventual participation in the nuclear fuel market. The precise extent of the country's uranium supply situation and recovery capability is not well known to the Western world. However, the PRC does have substantial uranium reserves (estimated at around 800,000 tonnes U_3O_8), a Bureau of Uranium Geology having a large staff, and a production rate adequate to supply military requirements and at least one or two small foreign supply contracts (one with a Japanese buyer). To feed the domestic nuclear power program the Chinese could choose to increase domestic production or to purchase uranium abroad, or a combination of methods. Whether or not enrichment needs would arise would depend on the choice of reactor technology for the national program, and any plans the government might formulate to expand domestic enrichment capacity beyond military requirements.

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UNITED STATES

In a sudden development at the end of May, UNC Resources, Inc. and General Atomic Company (now called GA Technologies, Inc., a wholly-owned subsidiary of Gulf) settled their longstanding (since 1975) legal dispute over uranium contracts. The settlement, which UNC valued at $300 million, ended what probably will be the last in the long series of antitrust litigations related to the Westinghouse uranium case.

It included three parts:

1. General Atomic's parent company, Gulf Corporation, recently acquired by Standard Oil Company of California (Socal), paid UNC $130 million on May 31.

2. Gulf assumed UNC's obligation (valued at $71 million by UNC) to repay to Pacific Gas and Electric Company (PG&E) some 2.3 million pounds U_3O_8 which UNC had borrowed.

3. Socal agreed to pay $100 million for unissued common stock in UNC. The price per share will be based on the highest average monthly price of UNC's common stock over the next six months, but subject to a maximum and a minimum such that Socal will acquire 5-8 million shares, at least 26 percent of UNC. Socal agreed further not to acquire any additional shares within the next three years without UNC's permission, and said that it is making the investment for investment purposes only. Finally, while Socal has not yet decided whether to seek a seat on the UNC Board of Directors, it did agree to vote the shares proportionately with other stockholders on most matters.

The settlement was, in Nuexco's opinion, prompted by the coincidental juxtaposition of three events.

1. On May 10, 1984, a New Mexico District Court found General Atomic Company (and its partners Gulf Oil Corporation and Scallop Nuclear, Inc.) liable to United Nuclear Corporation (a subsidiary of UNC Resources) for damages resulting from GAC's attempts to enforce (through litigation and arbitration) uranium contracts voided in 1978, when the New Mexico court found that participation by General Atomic and Gulf in an international uranium cartel had violated antitrust laws. UNC's original suit had been filed in 1975, and when GAC continued to try to enforce the original contracts, even after they were voided in 1978, UNC filed another suit in 1982, claiming $1 billion in consequential damages. A jury trial to determine the amount of damages to be awarded in that case, including the questions of treble damages and punitive damages, had begun during the week of May 21, but had been halted on May 25, pending the outcome of negotiations toward an out-of-court settlement.

2. The first portion of UNC's uranium loan (1,129,000 pounds U_3O_8) was due to be repaid to PG&E on July 1, 1984, and UNC almost certainly would have had to default.

3. Socal's acquisition of Gulf in the spring of this year must have had the effect of changing management attitudes at Gulf, formerly quite opposed to a settlement. It is reasonable to conclude that management became concerned about the possible consequences if UNC won a judgment for even a relatively small portion of the $1 billion they had sought. With treble damages and punitive damages also at issue, Socal/Gulf management could have been looking at a potential liability of $3 billion or more. Such a liability would have strained even their vast resources.

Thus, PG&E's loan repayment is assured by the financial strength, inventories and uranium production capacity of the huge Gulf-Socal combine, while UNC, having rid itself of this repayment obligation, is essentially out of the uranium business.

While this chapter of this complex litigation is closed, another is on the verge of opening. It is likely that Uranerz Canada Limited and Uranerz Exploration and Mining Limited will sue UNC over the uranium supply contract which UNC unilaterally abrogated earlier this year. That contract, concluded in 1981, was to have provided the 2.3 million pounds U_3O_8 with which UNC had intended to repay its PG&E loan. It is virtually certain that Uranerz will, at least, seek the difference between current low prices and the higher prices provided in the supply contract.

The UNC-Uranerz contract originally called for 4-5 million pounds U_3O_8, to be redelivered by UNC to the Tennessee Valley Authority (TVA) and to PG&E. All of the TVA material was delivered by Uranerz and paid for by UNC, but soon after the TVA deliveries were completed (deliveries on which UNC made a profit) UNC "gave notice of cancellation" of the portion of deliveries destined for PG&E (deliveries which would have required net cash outlay by UNC), citing "disagreements with the supplier."

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FINLAND

Introduction

Finland has exploited nuclear power remarkably successfully. Four operating units (Table 2) provide more than 40 percent of the nation's electricity, and nuclear electricity generation per capita is the highest in the world. Two utilities operate nuclear power plants, IVO (Imatran Voima Oy) and TVO (Teollisuuden Voima Oy). They have used different supply strategies to implement their programs: state-owned IVO has worked closely with the USSR, while privately-owned TVO has been supplied primarily through Western markets. For some time the utilities have considered joining forces to build a fifth nuclear unit. Their approach to that project is instructive of the economic lessons each has learned.

Finland is one of the Nordic nations bordering the Baltic Sea in northern Europe (Figure 1). It has a population of approximately 4.7 million, most of whom live in the South along the Baltic coast; all four nuclear power units are located on the southern coast. The country's dominant geographical considerations are its proximity to the Arctic and its long border with the USSR.

Energy Sources

Over the past decade nuclear energy has captured more than 40 percent of the nation's electricity market and 17 percent of primary energy consumption, largely at the expense of oil (Table 1). In addition to nuclear power's 40 percent, hydropower provides approximately 30 percent of electricity, while electricity-heat cogeneration projects using woodwaste, peat, coal and oil provide most of the remainder. Because of the country's wealth of timber and water resources, the government traditionally has promoted indigenous energy resources such as wood, hydropower, and peat. The national oil company Neste imports almost all crude oil from the USSR. Neste also markets natural gas obtained from the USSR through a pipeline across southeastern Finland, which began flowing in 1974. (Finland has a large trade surplus with the USSR despite substantial oil and gas imports.)

Nuclear Supplies

The Finnish utilities committed themselves to the commercial use of nuclear power in the early 1970s. At that time the country had some experience in the nuclear power field as a result of operating one research reactor (since 1962) and participating in various international nuclear power programs. Thus, while they were forced to use foreign vendors for all of their principal hardware supplies, both utilities participated extensively in the design and construction of their plants, absorbing directly approximately half of total costs.

Table 1

ENERGY CONSUMPTION BY SOURCE IN FINLAND[1]

Source	Percent Share 1973	Percent Share 1983
Oil	56	36
Nuclear	0	17
Wood, Etc.	19	15
Hydropower	11	13
Coal	9	9
Electricity Imports	5	5
Peat	0	3
Natural Gas	0	2
Total	100	100

[1] Source of Table: *European Energy Review*, May 18, 1984.

IVO ordered the main heavy components of its 445-MWe Loviisa units from Atomenergoexport of the USSR. Incorporating West German instrumentation and a Westinghouse-licensed condenser system, the state-owned utility managed construction of two hybrid Soviet PWRs. IVO purchases all fuel requirements and services for Loviisa from the USSR; the fuel package includes the return of spent fuel (after five years of storage), relieving the utility of the responsibility for long-term waste storage. Combining Finnish management with the Soviet supply package, IVO and Atomenergoexport are in a position to collaborate on reactor sales to third nations.

By contrast, TVO, which is a consortium of several Finnish utilities and industrial companies, ordered its two 660-MWe BWRs from Asea-Atom of Sweden (a General Electric licensee), and purchased the generators from Stal-Laval. TVO has long-term natural uranium supply contracts with Eldorado of Canada and Queensland Mines of Australia; Comurhex converts the Australian U_3O_8. Techsnabexport of the USSR supplies enrichment services to TVO, an arrangement attributable in part to the unavailability of other enrichment suppliers in the

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mid-1970s, when the utility made its fuel contracts. Asea-Atom and Kraftwerk Union provide fabrication services.

Despite choosing rather different supply approaches, IVO and TVO cooperate frequently in areas of common interest regarding nuclear power. Both utilities now have highly developed nuclear power capabilities. The government has been considering the construction of a fifth nuclear unit as one of the alternate means to fulfill an anticipated rise in electricity demand at the end of this decade. The likelihood of an order appears slim in the near future, in part because of the government's emphasis on the use of indigenous electricity sources, and partly because of Neste's gas and petroleum interests. However, IVO and TVO, which would pool resources to manage the fifth unit if it were ordered, requested Framatome and Atomenergoexport to bid on a proposed 1000-MWe unit in 1982. The utilities chose to request bids for the unit only from those two suppliers because of the strength and centrality of the French and Soviet nuclear power programs, and because only they would offer complete fuel packages.

Fuel Supply Considerations

IVO's fuel arrangement with the Soviets has been convenient for the utility, as it has eliminated the problems associated with coordinating a variety of suppliers for fuel cycle services—and it has eliminated the problem of long-term waste management. TVO must dispose of its own spent fuel (it is now building an on-site water pool facility scheduled for operation in 1988), and has criticized the international community for not cooperating to alleviate this problem for small nations such as Finland. In addition, TVO must accommodate the different requirements of several trading partners. For example, Canada requires that *all* Canadian-origin uranium that TVO ships into the USSR for enrichment must be removed, regardless of its form.

The major argument against IVO's fuel supply arrangement is that total reliance on the USSR could be crippling in the event of a severance of trade between the two nations. Likewise, the principal argument in favor of TVO's fuel supply situation is source diversity. Having good relations with its long-term suppliers, TVO has been able to adjust deliveries as requirements have changed. The utility has also reduced fuel costs by competing in open markets, including the spot market for U_3O_8. Neither IVO nor TVO has inventory problems or unfilled requirements in the near or intermediate term, and thus neither is currently an active participant in the nuclear fuel market.

Table 2

NUCLEAR POWER UNITS IN FINLAND

Unit	Utility	MWe Net	Type	Reactor Supplier	1983 Capacity Factor	COD[1]
Loviisa 1	IVO[2]	445	PWR	USSR	86.4	1977
Loviisa 2	IVO	445	PWR	USSR	90.4	1981
TVO 1	TVO[3]	660	BWR	Asea-Atom	83.6	1979
TVO 2	TVO	660	BWR	Asea-Atom	87.7	1982
Total MWe		2,210				

[1] COD = Commercial Operation Date.
[2] IVO = Imatran Voima Oy.
[3] TVO = Teollisuuden Voima Oy.

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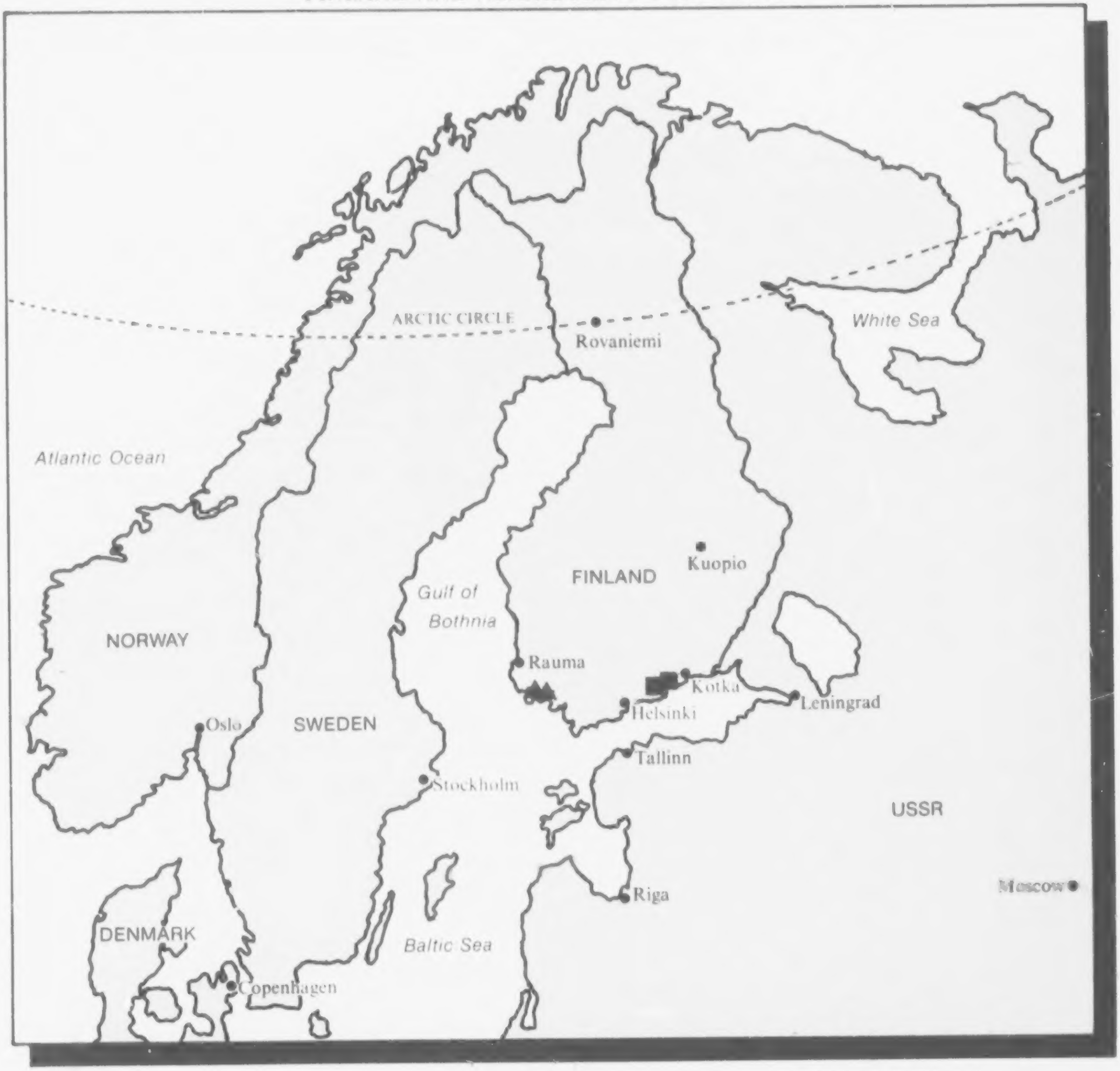
FOCUS

Figure 1
FINLAND AND NEIGHBORING COUNTRIES


ARCTIC CIRCLE
Rovaniemi
White Sea
Atlantic Ocean
FINLAND
Kuopio
Gulf of Bothnia
NORWAY
Rauma
Kotka
Helsinki
Leningrad
Oslo
SWEDEN
Tallinn
Stockholm
USSR
Riga
Moscow
DENMARK
Baltic Sea
Copenhagen

LEGEND ▲ 660-MWe BWR ■ 445-MWe PWR

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FRENCH URANIUM INDUSTRY STRUCTURE

Report 187 (March 1984) contains an article on the nuclear power and uranium industries in France. A number of points in that article regarding ownership relations of companies involved in uranium-related businesses require clarification or amplification. Figure 2 on page 20 of this Report presents a revised and amplified diagram superseding Figure 2 of the referenced article.

1. The revised figure is expanded to show interests in fuel fabrication companies and related entities. Framatome, France's PWR manufacturer (owned 50 percent each by CEA and Creusot Loire), is a primary participant in the fuel fabrication business. The joint company Fragema (50 percent each Cogema and Framatome) designs, licenses and markets fabricated fuel for Framatome's PWRs.

The three fabrication plants in which Fragema fuel is manufactured are managed by FBFC (Societe Franco-Belge de Fabrication de Combustible). FBFC owns only two of those plants — one in Dessel, Belgium, and one in Romans, France; CFC (Cogema Framatome Combustible) owns the other one, at Pierrelatte. FBFC is owned by Eurofuel (87 percent) and MNM (Compagnie Belge de Metallurgie et Mecanique Nucleaires) (13 percent). Equity ownerships in Eurofuel and CFC are identical: Pechiney controls 50 percent of each, and both Framatome and Cogema have 25 percent of each.

2. Both Pechiney and Cogema have substantial interests in the European nuclear fuel transport company Transnucleaire (27 percent and 24.3 percent respectively). Other owners of Transnucleaire are the French bank Paribas (24.9 percent) and Nukem GmbH (24.3 percent).

3. The first paragraph on page 28 of the referenced article states that Cogema owns 12.14 percent of Imetal. Cogema actually has a net beneficial interest in Imetal of 24 percent, as Cogema owns 66 percent of Cogerap, which holds 36 percent of Imetal.

4. The fourth paragraph on page 28 of the referenced article describes the ownership of Amok, the principal owner and operator of the Cluff Lake project in Saskatchewan. The ownership relations of Amok as presented are outdated. Cogema owns 38 percent (not 30 percent), Pechiney 25 percent (not 45 percent), and Mokta 37 percent (not 25 percent) of Amok. Amok owns 80 percent of the Cluff Lake project; SMDC (Saskatchewan Mining Development Corporation) owns the other 20 percent.

5. Note that Nuexco's interpretation of Cogema's interest in Eurodif has been revised slightly from 61.14 percent to 61.5 percent. For more information about the ownership of Eurodif, see the article on Eurodif on page 26 of Report 188 (April 1984).

6. There is a typographical error in the first paragraph on page 28. The fourth sentence states that Pechiney owns shares in Amok in Canada, Comuf in Gabon, and Somair in Nigeria. Somair (Societe des Mines de l'Air) operates in *Niger*, not Nigeria.

CORRECTION

South Africa

1. The May Report (Number 189) contains a copy of a speech entitled *South Africa's Role in the Uranium Market*. There is a typographical error on the first page of the speech insert in the third paragraph under the heading "South Africa." The third line should indicate that South Africa's gross domestic product in 1983 was 88 billion Rands rather than 80 billion Rands.

2. There is also a typographical error in Table 1 of the speech, entitled "South African Economic Indicators." The table indicates that the Average Working Cost per Ton Ore Milled increased by 35 percent between 1973 and 1982; it should indicate an increase of 350 percent.

3. Another typographical error appears on page 16 in the *Recent Developments* section of the May Report, under the heading "First Quarter Production." Line two should state that South African production remained steady during the first quarter of 1984 rather than 1983.

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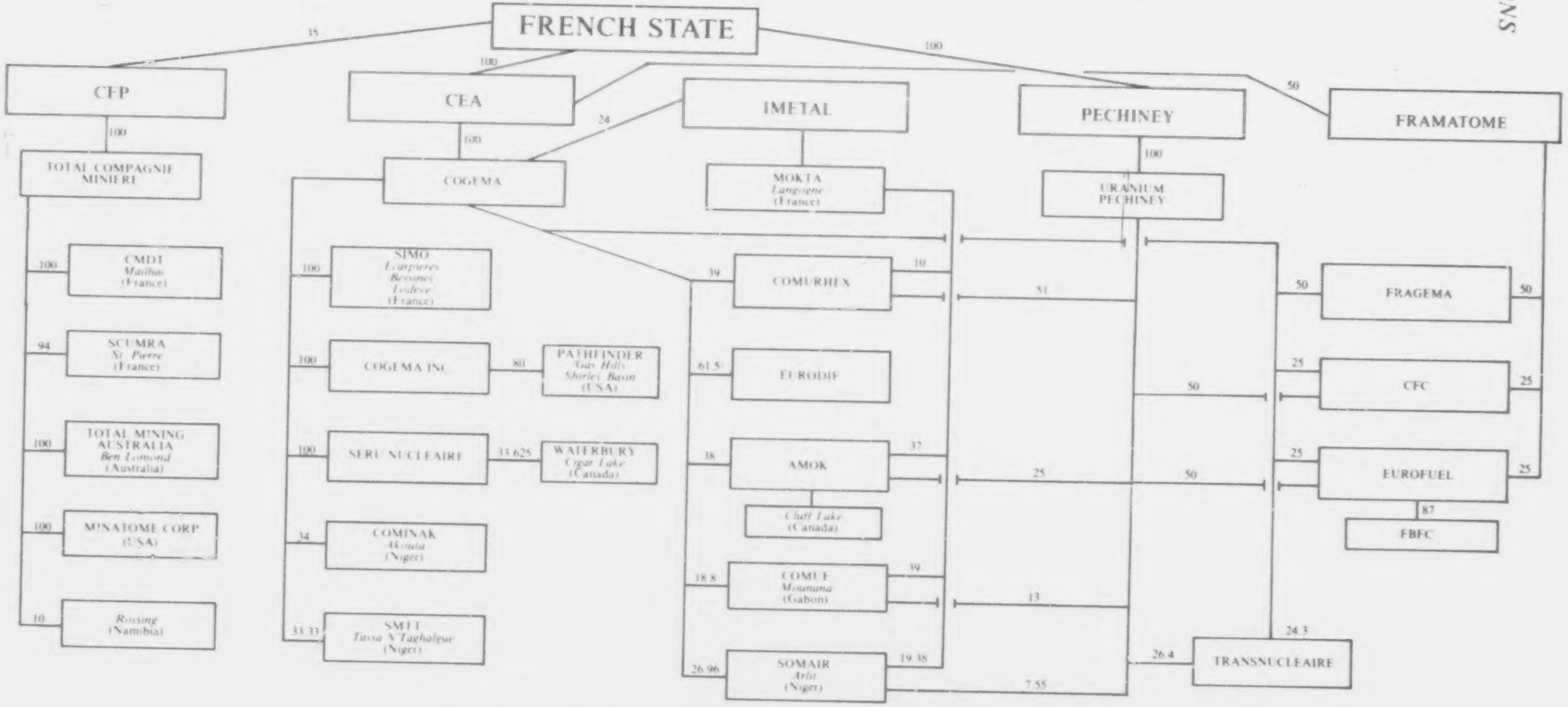
Figure 2

FRENCH OWNERSHIP INTERESTS IN URANIUM PROJECTS*


FRENCH STATE
35
100
100
CFP
CEA
24
IMETAL
PECHINEY
50
FRAMATOME
100
TOTAL COMPAGNIE MINIERE
100
COGEMA
MOKTA
Langogne
(France)
100
URANIUM PECHINEY
100
CMDT
Mailhac
(France)
94
SCUMRA
St Pierre
(France)
100
TOTAL MINING AUSTRALIA
Ben Lomond
(Australia)
100
MINATOME CORP
(USA)
10
Rossing
(Namibia)
100
SIMO
Lcarpieres
Bessines
Lodeve
(France)
100
COGEMA INC
80
PATHFINDER
Gas Hills
Shirley Basin
(USA)
100
SERU NUCLEAIRE
33.625
WATERBURY
Cigar Lake
(Canada)
34
COMINAK
Akouta
(Niger)
33.33
SMTT
Tassa N'Taghalgue
(Niger)
39
COMURHEX
10
51
61.5¹
EURODIF
38
AMOK
37
25
50
Cluff Lake
(Canada)
18.8
COMUF
Mounana
(Gabon)
19
13
26.96
SOMAIR
Arlit
(Niger)
19.38
7.55
26.4
TRANSNUCLEAIRE
24.3
50
FRAGEMA
50
25
CFC
25
25
EUROFUEL
25
87
FBFC

CEA	Commissariat a l'Energie Atomique
CFC	Cogema Framatome Combustible
CFP	Compagnie Francaise des Petroles
CMDT	Compagnie Miniere Dong-Trieu
COGEMA	Compagnie General des Matieres Nucleaires
COMINAK	Compagnie Miniere d'Akouta
FBFC	Societe Franco-Belge de Fabrication de Combustible
MOKTA	Compagnie Francaise de Mokta
SCUMRA	Societe Centrale de l'Uranium et des Minerais et Metaux Radioactifs
SERU	Societe d'Etudes et de Recherches d'Uranium
SIMO	Societe Industrielle des Minerais de L'Ouest
SMTT	Societe Miniere de Tassa N'Taghalque
SOMAIR	Societe des Mines de L'Air

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*This figure is a revised and amplified version of Figure 2 on page 29 of Report 187.

[1] Assumes Cogema controls share originally belonging to Iran Atomic Energy Organization. See pages 26–29 of Report 188.

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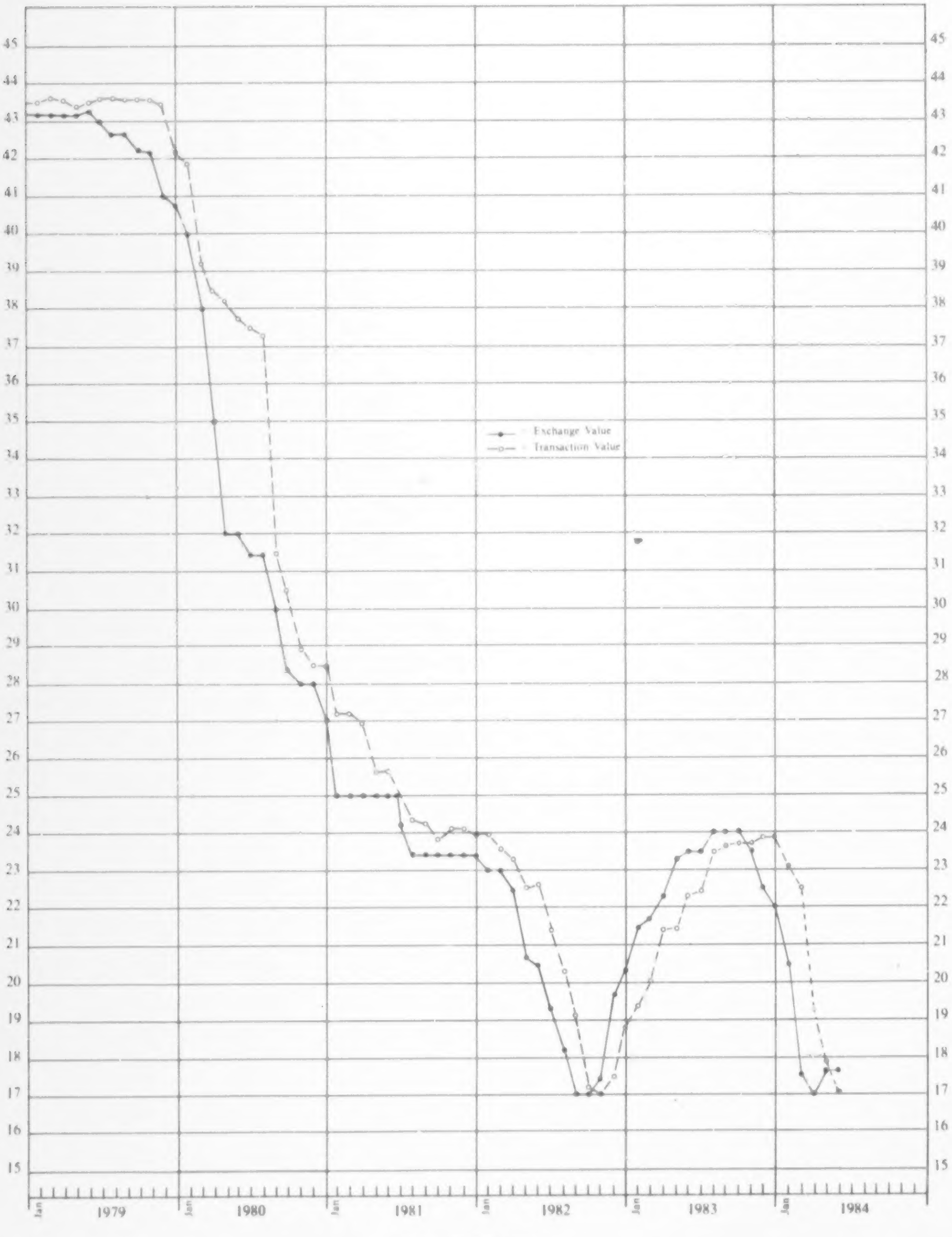
EXCHANGE AND TRANSACTION VALUES
SINCE JANUARY 1979

Determined as of the last day of the month indicated



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HISTORICAL MARKET DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	32.50	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00
1984	20.50	17.50	17.00	17.75	**17.75**							

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85
1984	23.05	22.50	19.25	17.90	**17.00**							

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US' Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60
1984	0.60	0.30	0.80	0.80	**0.80**							

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AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage Earners, Weekly Rates[2] (1976=100)
1972 Avg.	105.6	71.3
1973 Avg.	124.4	79.0
1974 Avg.	141.9	108.1
1975 Avg.	150.4	132.6
1976 Avg.	168.4	160.9
1977 Avg.	192.0	179.0
1978 Avg.[3] [4]	198.5	190.0
1979 Avg.	248.8	127.9
1980 Avg.	321.8	140.8
1981 Avg.	355.3	154.1
1982 Avg.[5]	368.6	174.9
1983 Avg.	401.6	181.8
Jan 1983	385.7	179.6
Feb 1983	387.5	179.8
Mar 1983	397.4	179.7
Apr 1983	407.6	180.0
May 1983	415.1	180.1
Jun 1983	415.9	180.2
Jul 1983	408.8	179.9
Aug 1983	403.5	179.9
Sep 1983	403.4	179.8
Oct 1983	398.0	187.6
Nov 1983	396.0R	187.6
Dec 1983	399.7R	187.4
Jan 1984	399.6P	187.6
Feb 1984	—	187.4
Mar 1984	—	187.4

P = Preliminary R = Revised since last month

[1] Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0).

[2] Australian Bureau of Statistics, Canberra: "Award Rates of Pay Indexes, Australia" (Catalogue No. 6312.0). Figures for the latest fourteen months shown are subject to revision.

[3] Monthly data for 1970-78 appear on pages 4.7 and 4.8 of Report 138.

[4] Annual averages prior to 1979 reflect index base no longer in use.

[5] Monthly data for 1979-82 appear on page 35 of Report 184.

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GOVERNMENT STATISTICS

CANADA

	Industry Selling Price Index: Manufacturing[1] (1971=100)	Wage-earner Data: Average Hourly Earnings (C$)[2]						
		Uranium Mines (SIC 057)	Metal Mines (SIC 051-059)	Mines, Quarries and Oil Wells[3] (SIC 051-099)	Primary Metal Industries Non-ferrous[4]			Chemicals and Chemical Products[5] (SIC 370-379)
					(SIC 296)	(SIC 296-298)	(SIC 298)	
1979 Avg.[6]	217.9	—	9.60	9.66	—	7.35	—	7.67
1980 Avg.	247.2	—	10.59	10.80	—	8.05	—	8.50
1981 Avg.	288.7	—	12.02	12.23	—	9.03	—	9.53
1982 Avg.[7]	288.8	—	13.74	13.92	—	9.98	—	10.63
1983 Avg.	298.8	—	14.69	14.30	—	—	—	11.17
Jan 1983	292.7	—	14.36	14.35	—	10.72	—	11.06
Feb 1983	293.5	—	14.24	14.28	—	10.74	—	11.06
Mar 1983[8]	295.2	16.79	14.84	14.48	—	10.93	—	11.21
Apr 1983	297.1	16.83	14.40	14.13	11.57	—	10.10	11.02
May 1983	298.5	17.02	14.50	14.10	11.39	—	9.82	10.97
Jun 1983	299.3	17.02	14.60	14.07	11.33	—	9.84	11.05
Jul 1983	300.4	16.48	14.35	13.93	11.70	—	9.83	11.04
Aug 1983	301.3	16.93	14.36	13.89	11.82	—	10.08	11.19
Sep 1983	301.1	17.66	14.90	14.41	11.99	—	10.32	11.29
Oct 1983	301.6	17.73	15.27	14.65	11.76	—	10.03	11.30
Nov 1983	301.8R	17.82	15.29	14.67	11.78	—	10.62	11.38
Dec 1983	302.8R	17.84	15.11	14.66	11.86	—	10.60	11.51
Jan 1984	305.4R	17.74	15.27	14.74	11.91	—	10.84	11.69
Feb 1984	306.6R	17.78	15.59R	14.90R	12.04R	—	10.82R	11.51R
Mar 1984	308.7	—	—	—	12.10P	—	10.95	11.58
Apr 1984	310.3	—	—	—	—	—	—	—

P = Preliminary R = Revised since last month

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[1] Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (Catalogue 62-011). Indexes for the most recent six months shown are subject to revision.

[2] Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa "Employment, Earnings and Hours" (Catalogue 72-002).

[3] Reports 175 through 185 list this series title incorrectly as "Metal Mining, Including Milling (SIC 050-099)".

[4] Beginning with the April 1983 figure, Primary Metal Industries, non-ferrous is split into SIC 296 and SIC 298.

[5] Chemical and Chemical Products prior to April 1983 was SIC 370-379. The new series is from a new survey which includes all companies and is based on a 1970 classification. The old survey only included companies of 20 employees or more.

[6] Monthly ISPI for 1977 and 1978 appear on page 4.10 of Report 138, and monthly wage-earner data for 1973-78 appear on page 4.11 of Report 138.

[7] Monthly data for 1979-1982 appear on page 37 of Report 184. On that page, the wage earner index entitled "Metal Mining, Including Milling (SIC 050-099)" should read "Total Mining (SIC 051-099)".

[8] Beginning with the April 1983 figure, Wage Earner Data are based on a census of all companies employing 200 or more wage earners, *plus* a random survey of companies employing fewer than 200 wage earners. Prior to April 1983 only companies employing 200 or more wage earners are included in the Wage Earner Data.

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REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per per Metric Ton of Gold Ore Milled (Rand)[1]	Tonnage-Weighted Index of Average Working Costs per Metric Ton of Gold Ore Milled (March 1982=100)[2]	Consumer Price Index[3] (1975=100)[4]	Producer Price Index All Groups[5] (1975=100)	Total Employment in Mining and Quarrying (Code 35)[6]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[6]
1972 Avg.	8.79	—	113.3	63.9	623,067	443,933
1973 Avg.	10.51	—	124.1	72.3	684,743	572,133
1974 Avg.	13.18	—	138.5	85.3	674,140	761,596
1975 Avg.	16.71	—	157.2	100.0	639,473	1,003,617
1976 Avg.	19.30	—	174.7	115.1	671,240	1,212,983
1977 Avg.	23.87	—	194.4	130.0	712,006	1,420,670
1978 Avg.	27.14	—	137.2	142.7	664,571	1,537,169
1979 Avg.[7]	30.18	—	155.3	164.5	692,209	1,830,632
1980 Avg.[8]	35.53	—	176.7	192.1	714,379	2,279,615
1981 Avg.	41.89	—	206.5	218.3	728,506	2,820,505
1982 Avg.[9]	47.25	104.2	233.5	248.7	707,552	3,246,071
1983 Avg.	51.87	115.0	262.2	274.8	696,579	3,644,772
Jan 1983	—	—	249.0	264.9	688,030	289,075
Feb 1983	—	—	253.1	267.4	697,089	281,413
Mar 1983	50.35	111.2	255.9	269.1	695,976	290,586
Apr 1983	—	—	257.8	270.9	697,158	286,708
May 1983	—	—	259.7	274.1	701,712	295,701
Jun 1983	50.51	111.9	260.8	273.1	706,933	300,177
Jul 1983	—	—	262.5	273.7	704,202	314,566
Aug 1983	—	—	265.6	278.9	698,984	311,789
Sep 1983	52.92	117.4	267.3	279.4	696,435	312,264
Oct 1983	—	—	270.0	281.0	693,225	311,418
Nov 1983	—	—	271.4	281.6	688,459	317,485
Dec 1983	53.70	119.6	273.2	283.7	690,750	333,595
Jan 1984	—	—	274.7	283.3	689,807	326,619
Feb 1984	—	—	278.4	286.5	—	—
Mar 1984	55.30	123.1	281.9	288.0	—	—
Apr 1984	—	—	286.1	—	—	—

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[1] Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly.

[2] Page 16 of Report 178 contains description and calculation of index, and page 24 of Report 178 lists figures for 1982.

[3] Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."

[4] For annual averages prior to 1978, April 1970 = 100.

[5] Previously known as the Wholesale Price Index, now the Producer Price Index. The computation remains the same.

[6] Bulletin of Statistics, Department of Statistics, Pretoria.

[7] Historical data for the Average Declared Working Costs and Consumer Price Index 1970-1979 appear on page 4.9 of Report 140.

[8] Monthly data for Codes 35 and 40, 1977-1980, appear on page 28 of Report 157.

[9] Monthly data for 1979-82 appear on page 39 of Report 184.

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GOVERNMENT STATISTICS

UNITED STATES

	Producer Price Index[1]		Consumer Price Index[2] (1967=100)	GNP Implicit Price Deflator[3] (1972=100)	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
	Industrial Commodities (1967=100)	All Commodities (1967=100)			Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1972 Avg.	117.9	119.1	125.3	100.00	4.56	4.59	4.26	3.71
1973 Avg.	125.9	134.7	133.1	105.75	4.84	4.98	4.51	3.91
1974 Avg.	153.8	160.1	147.7	115.08	5.44	5.63	4.88	4.21
1975 Avg.	171.5	174.9	161.2	125.79	6.13	6.24	5.39	4.64
1976 Avg.	182.4	183.0	170.5	132.34	6.76	6.87	5.91	4.96
1977 Avg.	195.1	194.2	181.5	140.05	7.28	7.67	6.43	5.39
1978 Avg.[5]	209.4	209.3	195.4	150.42	8.23	8.56	7.02	5.82
1979 Avg.	236.5	235.6	217.4	163.42	9.27	9.50	7.60	6.32
1980 Avg.	274.8	268.8	246.8	178.64	10.26	10.63	8.30	6.94
1981 Avg.	304.1	293.4	272.4	195.51	11.55	11.98	9.12	7.62
1982 Avg.[6]	312.3	299.3	289.1	207.15	12.33	12.94	9.96	8.21
1983 Avg.	315.8	303.1	298.4	215.63	12.67	13.44	10.58	8.66
Jan 1983	313.9	299.9	293.1	—	12.63	13.33	10.34	8.53
Feb 1983	313.9	300.9	293.2	—	12.66	13.29	10.41	8.56
Mar 1983	313.5	300.6	293.4	212.83	12.48	13.35	10.39	8.60
Apr 1983	312.4	300.6	295.5	—	12.67	13.34	10.43	8.60
May 1983	313.6	301.5	297.1	—	12.55	13.62	10.50	8.60
Jun 1983	315.3	302.4	298.1	214.55	12.66	13.38	10.52	8.63
Jul 1983	316.5	303.2	299.3	—	12.68	13.56	10.58	8.69
Aug 1983	317.3	304.7	300.3	—	12.63	13.46	10.61	8.64
Sep 1983	317.1	305.3	301.8	216.44	12.71	13.47	10.69	8.75
Oct 1983	318.5	306.0	302.6	—	12.78	13.56	10.78	8.73
Nov 1983	318.3	305.5	303.1	—	12.72	13.56	10.86	8.78
Dec 1983	318.4	306.1R	303.5	218.53	12.85	13.34	10.89	8.86
Jan 1984	319.2	308.1	305.2	—	12.78	13.39	10.90	8.89
Feb 1984	320.4	308.8	306.6	—	12.88R	13.35R	10.89	8.87R
Mar 1984	321.9	311.1	307.3	220.52R	12.86P	13.32P	10.92R	8.90R
Apr 1984	322.5	311.4	308.8	—	—	—	10.98P	8.91P

P = Preliminary R = Revised since last month

[1] US Bureau of Labor Statistics, Washington, D.C.: "Producer Prices and Price Indexes," (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

[2] US Bureau of Labor Statistics, Washington, D.C.: Consumer Price Index for All Urban Consumers, US City Average, All Items.

[3] US Department of Commerce, Washington, D.C.: Bureau of Economic Analysis, National Income and Wealth Division: "Survey of Current Business." The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

[4] US Bureau of Labor Statistics, Washington, D.C.: "Employment and Earnings." 2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for 1977-1978 are adjusted to the March 1979 benchmark. Data for January 1979 and beyond are adjusted to the March 1980 benchmark.

[5] Monthly data 1970-1978 for Producer Price Index-Industrial Commodities, Consumer Price Index, and Employment and Earnings SIC codes 10, 333, and 28, and quarterly data for GNP Implicit Price Deflator appear on pages 4.6-4.8 of Report 139.
Monthly data 1977-1978 for Employment and Earnings SIC Codes 10, 333, and 28 appear on page 33 of Report 147.
Monthly data 1970-1978 for Employment and Earnings SIC Code 36 appear on page 23 of Report 154.
Monthly data 1977-1980 for Producer Price Index-All Commodities, appear on page 21 of Nuexco Report 158.

[6] Monthly data 1979-1982 for all listed indices appear on page 41 of Report 184.

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FUEL POLICY MODEL

Nuexco has developed a model to aid utilities in managing the procurement of U_3O_8 and related services in the front end of the nuclear fuel cycle. The model considers the future price relationships of uranium in its various forms, such as U_3O_8, UF_6 and low enriched uranium (LEU). Given a utility's unique financial and physical constraints and a set of projected market prices, the model is used to determine the optimum policy of acquisition of these commodities and for the management of the out-of-core fuel inventory.

Called the Nuexco Fuel Policy Model, it is a specific application of linear programming to the issues of multi-year planning for nuclear fuel inventory management. Briefly, it permits the planner to consider both the present prices and future price forecasts of U_3O_8, related fuel services and interest rates. Different utility policies, such as allowable market activities and desired inventory levels can be incorporated, as well as the desired utility's forecast of demand for fuel throughout a given planning period. In the Nuexco Fuel Policy Model, the amount of fuel required in any period is specified, with certain resources on hand or available in the market. The problem is to allocate the available resources to meet fuel demands in the most economical way.

The fuel policy model consists of two submodels: the *Arbitrage* model and the *Linear Program*. The Arbitrage model is a network optimization system which determines the least cost path between two defined endpoints for a four commodity network which includes cash, U_3O_8, UF_6, and enriched uranium. As an example, given a starting point of "UF_6 on hand in 1984" and an ending point of "UF_6 on hand in 1990," in each year the Arbitrage model considers the alternatives of holding UF_6, performing a deconversion swap and holding U_3O_8, or selling UF_6 for cash and holding cash (with subsequent purchase in a later year). The Arbitrage model can be used separately to analyze simple decisions. It is also used to derive input for the Linear Program.

The Linear Program is a technique for solving a general class of optimization problems dealing with the interaction of many *decision variables* which are subject to certain restricting conditions. In solving these problems, an *objective function* such as the minimum cost of nuclear fuel is obtained in the best fashion, subject to *constraints*.

For the case of nuclear fuel management, the objective function is defined as the minimum fuel cost to the ratepayers over a period of time. The decision variables are the amounts of uranium, conversion, and enrichment to be purchased, held, loaned, sold, etc., in each year. Typical constraints are limits to financial resources, fuel demand in certain periods, and minimum inventories.

The linear programming technique also furnishes sensitivity information, providing the limits on the constraints for which the optimum solution will remain in effect. This information allows the resource manager insight on how much limits such as cash flow can be reduced without increasing fuel costs.

The linear programming technique used solves the "dual problem." When the optimum solution is constrained, the dual program generates "shadow costs," i.e., the potential for additional cost reduction if additional resources were available. For inventory management, these shadow costs quantify the costs of constraining cash flow or credit.

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EXECUTIVE SUMMARY
REPORT 191
(All data as of June 30, 1984)

Exchange Value **$17.50, down $0.25**	The **Exchange Value** is **$17.50** per pound U_3O_8, down $0.25 since last month. Four recent transactions are reported, two involving concentrates and two natural UF_6.
Supply-Demand Ratio **unchanged at 2.2:1**	Active spot and near-term **uranium supply** amounts to **4.3 million** pounds U_3O_8 equivalent, down 900 thousand pounds from last month. Active spot and near-term **uranium demand** totals **1.9 million** pounds, down 500 thousand pounds. The spot and near-term **supply-demand ratio** remained at **2.2:1.**
Transaction Value **fell $0.50, to $16.50**	The **Transaction Value** is **$16.50** per pound U_3O_8, down $0.50 since last month. It includes 18 transactions involving a total of 5.4 million pounds U_3O_8 and equivalent UF_6 and covers a period of 4 months.
Loan Use Charge Rate **unchanged at 6%**	The **Loan Use Charge Rate** remains **6 percent** per annum.
Conversion Value **dropped to zero**	The **Conversion Value** is **$0.00** (zero) per pound U as UF_6, down $0.80 since last month. No secondary market conversion transactions are reported. Active secondary market supply of conversion services for delivery within three years totals 2.8 million pounds U as UF_6. For the third month in a row, no active demand is reported.
SWU Values **$95 for DOE-origin (FY85)** **$80 for non-DOE origin** **(delivery within 15 months)**	The **SWU Values** are **$95** per SWU of DOE origin and FY85 delivery, down $10 since last month, and **$80** per SWU of non-DOE origin, unchanged. No SWU transactions are reported. Active secondary market SWU supply amounts to 405 thousand SWUs, while active demand totals 175 thousand SWUs.
Commentary	Nuexco's chairman, Mr. J.R. Wolcott, presents his views on the role of the US Department of Energy in the enrichment services market.
Basic Considerations	The Urenco group is steadily expanding its low-cost centrifuge enrichment operations, and actively seeks outside business to fulfill its long-term plans for growth.
Japan	A site has been proposed for location of commercial enrichment, waste storage, and reprocessing facilities. Nuclear power generated a disproportionately high share of electricity in FY83, and operating plants set a record for average capacity factor.
Central Africa	Uranium production from three uranium projects in Gabon and Niger totalled 11.5 million pounds U_3O_8 in 1983. Some reduction of output appears likely this year in Niger.

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NUEXCO REPORT 191 FIGURES OF THE MONTH (June 30, 1984)	This Month (Report 191)	Last Month (Report 190)	12 Months Ago (Report 179)
Exchange Value[1]	17.50	17.75	23.50
Transaction Value[1]	16.50	17.00	22.45
Conversion Value[2]	0.00	0.80	1.20
Loan Use Charge Rate[3]	6%	6%	6%
Near-Term Uranium Supply[4]	4.3	5.2	6.0
Near-Term Uranium Demand[5]	1.9	2.4	2.3
Near-Term Supply-Demand Ratio	2.2	2.2	2.6
Recent Uranium Sales:			
Number of Transactions[6]	4	9	4
Quantity of Material[7]	5.8	3.5	1.3-3.7
Nuexco SWU Values:[8]			
DOE origin, FY85 delivery	95	105	—
non-DOE origin, delivery within 15 months	80	80	—
USDOE SWU Prices:			
USEC	135.00	135.00	—
AFC	153.00[9]	153.00[9]	138.65
Requirements	157.00[9]	157.00[9]	149.85
Market Value of Enriched UF$_6$[10, 11]:			
2.5 w/o U$_{235}$	512.54	555.72	619.44
3.0 w/o U$_{235}$	659.57	715.89	792.80
3.5 w/o U$_{235}$	809.59	879.36	969.24
4.0 w/o U$_{235}$	961.65	1,045.09	1,147.96

---

[1] US $ per pound U$_3$O$_8$ equivalent.

[2] US $ per pound U as UF$_6$.

[3] Per annum.

[4] Active inquiries to sell, for delivery within 12 months after contract signing (millions of pounds U$_3$O$_8$).

[5] Active inquiries to purchase, for delivery within 12 months after contract signing (millions of pounds U$_3$O$_8$).

[6] Uranium sales only; does not include loans, conversion, or SWU transactions.

[7] Millions of pounds U$_3$O$_8$, equivalent.

[8] US $ per SWU.

[9] Effective 10/1/84.

[10] Calculated using the Nuexco Exchange Value, Conversion Value, and 0.20 percent tails assay. From 2/28/83 through 9/30/83, calculations used the Nuexco SWU Value for the relevant fiscal year. From 10/31/83 through 2/29/84, calculations used the Nuexco SWU Value for DOE origin and FY84 delivery. As of 3/31/84, calculations use the Nuexco SWU Value for DOE origin and FY85 delivery.

[11] US $ per KgU as UF$_6$.

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JULY 1984 NUMBER 191

MONTHLY REPORT

ON THE NUCLEAR FUEL MARKET

NUEXCO

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MONTHLY REPORT ON THE NUCLEAR FUEL MARKET
July 1984 No. 191

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PRICING

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NATURAL URANIUM AND CONVERSION

The **Exchange Value** as of June 30, 1984 is **$17.50** per pound U_3O_8, down $0.25 since last month. The *Current Market Data* section of this Report lists four uranium sales transactions, involving a total of approximately 5.8 million pounds U_3O_8 *equivalent*. Two of those transactions were sales of concentrates and two involved natural UF_6.

Active supply of uranium (U_3O_8 and UF_6) for spot and near-term delivery totals **4.3 million** pounds U_3O_8 or equivalent UF_6, down 900 thousand pounds since last month. The corresponding figure for **active demand** is **1.9 million** pounds, down 500 thousand pounds. The spot and near-term **supply-demand ratio** remained **2.2:1.**

The **Transaction Value** as of June 30, 1984 is **$16.50** per pound U_3O_8, down $0.50 since last month primarily due to the addition of one large UF_6 transaction at a price well below the current Exchange Value. The current Transaction Value includes 18 transactions involving a total of 5.4 million pounds U_3O_8 or equivalent UF_6 and covers a period of 4 months.

The **Loan Use Charge Rate** as of June 30, 1984 is **6 percent** per annum, unchanged since last month. No uranium loans are reported.

* * *

The Exchange Value fell $0.25 during June after sellers' offers near the previous month's level failed to elicit firm buyer responses. While some sellers are offering at prices above $17.50, there is a significant quantity of material available at or below that level. The near-term demand for uranium has decreased steadily over the past few months. Approximately half of the current demand comes from utilities in little hurry to make purchasing decisions. The other half of demand is comprised primarily of discretionary buyers interested only in bargain prices. A significant spread exists between most sellers' offering prices and the interest level of the discretionary buyers that dominate the market.

* * *

The **Conversion Value** is **$0.00** (zero) per pound U in UF_6 as of June 30, due to the continued absence of demand for conversion services and the ability of holders of concentrates to swap for natural UF_6 at no cost. The most active natural UF_6 sellers have been willing to swap their UF_6 for U_3O_8 at no cost in order to meet certain uranium buyers' preferences for U_3O_8. Although similar market conditions have existed for several months, Nuexco had refrained from dropping the Conversion Value to zero in the past because some potential buyers had expressed a willingness to pay some small amounts for conversion. However, for the past three months there has been no active demand for secondary market conversion services, and, as of June 30, Nuexco knew of no buyers willing to consider paying anything for secondary market conversion services.

No secondary market conversion transactions are reported this month. The *Pricing* section of last month's Report (Number 190) made reference to a conversion transaction in which a "primary supplier had in effect competed with secondary market prices." The transaction involved less than 100 thousand pounds U in UF_6, and contrary to the implication of the referenced article, the price involved was *not* directly competitive with current secondary market prices. Furthermore, the transaction was *not arm's length*, and for that reason (as well as the fact that it was a primary, not a secondary, market sale) was not included on the transaction page of the same Report.

SECONDARY MARKET ENRICHMENT SERVICES

The **SWU Values** as of June 30, 1984 are **$95** for **DOE origin** and **FY85 delivery,** down $10, and **$80** for **non-DOE origin** and delivery within approximately 15 months (unchanged). No secondary market SWU sales are reported. Active secondary market supply of enrichment services totals approximately 405 thousand SWUs, down sharply since last month, while active demand amounts to 175 thousand SWUs, also sharply down.

Several buyers previously considered active have withdrawn from the market temporarily in order to reassess the developing SWU market. Thus, they are listed as inactive in the SWU demand table of the *Current Market Data* section of this Report. Much of the inactive SWU demand is comprised of probable USEC signers that have not made final decisions regarding the contract. Near-term SWU supply has been falling steadily during the past few months, but recent offers have been below the levels of previous months, mainly because the few active sellers are competing for limited active demand. Nuexco is aware of numerous potential SWU sellers that will enter the market if and when near-term SWU demand rises substantially because of firm decisions to convert to the USEC. (Table 1 presents a summary of responses to the USEC to date.)

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One of the reasons some potential SWU buyers may be hesitating to participate in the near-term SWU market is the possibility that DOE will offer additional price concessions related to the USEC. For example, the director of DOE's enrichment operations reportedly backs the idea of DOE selling SWUs for a portion of requirements at the "marginal cost of production" (which may be less than $80). As most utilities are under no time pressure regarding their enrichment decisions, they are willing to wait until DOE has offered final pricing terms.

Table 1

REGIONAL STATUS OF CONVERSION TO USEC
(Expressed in GWe of Generating Capacity)

	Former Status		
	Requirements Contracts		
Current Status	**3.5-year**	**5-year**	**Fixed-Commitment Contracts**
USA			
Signed	—	10.3	8.3
Indicated Intent to Sign[1]	22.6	19.3	27.0
No Indication	8.2	3.5	11.2
Indicated Will Not Sign	0.5	—	—
Europe			
Signed	—	—	—
Indicated Intent to Sign[1]	—	—	—
No Indication	6.8	1.2	19.8
Indicated Will Not Sign	1.0	0.4	—
Japan			
Signed	—	—	—
Indicated Intent to Sign[1]	—	—	1.1
No Indication	3.6	5.6	13.8
Indicated Will Not Sign	—	—	—
Other			
Signed	—	—	—
Indicated Intent to Sign[1]	—	—	8.5
No Indication	—	—	0.6
Indicated Will Not Sign	—	—	—

[1] Category is not limited to letters of intent that DOE has received, but also includes other indications of intent to convert.

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CURRENT MARKET DATA

June 30, 1984	Market Values	Active Supply[1] (thousands)	Active Demand[1] (thousands)
EXCHANGE VALUE	**$17.50**/lb. U_3O_8	4,305	1,945
CONVERSION VALUE	**$0.00**/lb. U in UF_6	2,825	0
SWU VALUES			
DOE origin, FY85 delivery	**$95**/SWU	405	175
non-DOE origin, delivery within 15 months	**$80**/SWU		
LOAN USE CHARGE RATE	**6%**/annum	7,050	500

	$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
TRANSACTION VALUE	**16.50**	5.4	18	4

[1] Supply and demand tables in the *Current Market Data* section of this Report detail the numbers for each category. Quantities of SWUs (Separative Work Units) are not referenced to a particular origin.

DEFINITIONS

1. The **Exchange Value** is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.
2. The **Conversion Value** is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.
3. The **SWU Values** represent Nuexco's judgment of the price at which transactions for the sale of significant quantities of SWUs of stated origin for delivery in the specified time period could be concluded as of the date indicated.
4. The **Loan Use Charge Rate** is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.
5. The **Transaction Value** is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:
   a. Transactions closed within the previous three-month period for which delivery is scheduled within one year of the transaction date;
   b. At least ten transactions;
   c. Transactions involving a sum total of at least 2 million pounds U_3O_8 equivalent.

   The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars using conversion rates in effect on or near the transaction date.

DERIVATIONS AND COMMENTS

1. All Market Values are based on:
   a. Data from recently completed transactions.
   b. Data from pending transactions.
   c. Firm bids to buy or borrow, and firm offers to sell or lend.
   d. Prices purchasers or rates borrowers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy or borrow, and prices sellers or rates lenders have expressed a willingness to offer, but for which Nuexco is not aware of firm offers to sell or lend.
2. Prices associated with deliveries under old or renegotiated contracts or other than arm's-length transactions are not considered in the determination of these Market Values.
3. In the determination of the Conversion Value, Nuexco does not consider transportation charges other than those customarily provided by primary suppliers of conversion services.
4. The prices of conversion services or SWUs delivered under long-term contracts with primary suppliers are not considered in the determination of either the Conversion Value or SWU Value.
5. For the SWU Values, Nuexco converts SWU prices at varying tails and product assays to equivalent SWU prices at the DOE Reference Transaction Tails Assay (presently 0.20 weight-percent U_{235}) and a product assay of 3.0 weight-percent U_{235}, assuming feed costs corresponding to Nuexco's Exchange and Conversion Values determined as of the same date.
6. In calculating the Transaction Value, Nuexco does not account for the price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of future Exchange Values or any other indeterminant variable. Also excluded from the calculation are any other transactions in which the delivery price is defined in such a way that it cannot currently be determined.

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CURRENT MARKET DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
Country (currency)	**This Month (June 30, 1984)**	**Last Month (May 31, 1984)**	**12 Months Ago (June 30, 1983)**	**This Month (June 30, 1984)**	**Last Month (May 30, 1984)**	**12 Months Ago (June 30, 1983)**
Australia (dollar)	20.21	19.74	26.83	52.55	51.33	69.76
Belgium (comm. franc)	992.06	986.66	1,194	2,579	2,565	3,104
Canada (dollar)	23.03	22.97	28.86	59.87	59.72	75.02
Finland (markka)	103.24	102.84	130.34	268.41	267.36	338.85
France (franc)	149.57	148.91	179.54	388.86	387.13	466.76
FRG (mark)	48.71	48.51	59.81	126.62	126.12	155.50
Italy (lira)	30,027	29,963	35,445	78,065	77,897	92,149
Japan (yen)	4,152	4,107	5,635	10,794	10,677	14,651
Netherlands (guilder)	54.88	54.72	67.05	142.67	142.25	174.31
South Africa (rand)	23.68	22.73	25.67	61.56	59.09	66.73
Spain (peseta)	2,766	2,726	3,406	7,191	7,087	8,854
Sweden (krona)	143.09	143.49	179.66	372.00	373.05	467.09
Switzerland (franc)	40.75	40.12	49.45	105.93	104.31	128.57
UK (pound)	12.94	12.81	15.38	33.65	33.29	40.00
US (dollar)	17.50	17.75	23.50	45.50	46.15	61.09

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
Country (currency)	**This Month (June 30, 1984)**	**Last Month (May 31, 1984)**	**12 Months Ago (June 30, 1983)**	**This Month (June 30, 1984)**	**Last Month (May 31, 1984)**	**12 Months Ago (June 30, 1983)**
Australia (dollar)	19.06	18.91	25.63	49.55	49.16	66.64
Belgium (comm. franc)	935.37	944.97	1,141	2,432	2,457	2,966
Canada (dollar)	21.71	22.00	27.57	56.45	57.20	71.67
Finland (markka)	97.35	98.49	124.51	253.08	256.06	323.71
France (franc)	141.03	142.62	171.52	366.64	370.77	445.91
FRG (mark)	45.92	46.46	57.14	119.39	120.79	148.55
Italy (lira)	28,312	28,697	33,861	73,604	74,605	88,032
Japan (yen)	3,915	3,933	5,384	10,177	10,226	13,996
Netherlands (guilder)	51.74	52.40	64.05	134.51	136.24	166.52
South Africa (rand)	22.33	21.77	24.52	58.05	56.59	63.75
Spain (peseta)	2,608	2,611	3,254	6,780	6,788	8,459
Sweden (krona)	134.91	137.43	171.64	350.75	357.29	446.22
Switzerland (franc)	38.42	38.43	47.24	99.88	99.90	122.82
UK (pound)	12.20	12.27	14.70	31.73	31.89	38.21
US (dollar)	16.50	17.00	22.45	42.90	44.20	58.37

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[1] Calculated using currency exchange rates published in the *Wall Street Journal* on June 29, 1984.

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CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

	per lb. U as UF_6			per kg. U as UF_6		
Country (currency)	**This Month (June 30, 1984)**	**Last Month (May 31, 1984)**	**12 Months Ago (June 30, 1983)**	**This Month (June 30, 1984)**	**Last Month (May 31, 1984)**	**12 Months Ago (June 30, 1983)**
Australia (dollar)	0.00	0.89	1.37	0.00	1.96	3.02
Belgium (comm. franc)	0.00	44.47	60.98	0.00	98.04	134.43
Canada (dollar)	0.00	1.04	1.47	0.00	2.28	3.25
Finland (markka)	0.00	4.64	6.66	0.00	10.22	14.67
France (franc)	0.00	6.71	9.17	0.00	14.80	20.21
FRG (mark)	0.00	2.19	3.05	0.00	4.82	6.73
Italy (lira)	0.00	1,350	1,810	0.00	2,977	3,990
Japan (yen)	0.00	185.10	287.77	0.00	408.07	634.42
Netherlands (guilder)	0.00	2.47	3.42	0.00	5.44	7.55
South Africa (rand)	0.00	1.02	1.31	0.00	2.26	2.89
Spain (peseta)	0.00	122.87	173.91	0.00	270.88	383.41
Sweden (krona)	0.00	6.47	9.17	0.00	14.26	20.23
Switzerland (franc)	0.00	1.81	2.53	0.00	3.99	5.57
UK (pound)	0.00	0.58	0.79	0.00	1.27	1.73
US (dollar)	0.00	0.80	1.20	0.00	1.76	2.65

SWU VALUES EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	**DOE SWU FY85 (June 30, 1984)**	**DOE SWU FY85 (May 31, 1984)**	**Non-DOE SWU delivery within 15 months (June 30, 1984)**	**Non-DOE SWU delivery within 15 months (May 31, 1984)**
Australia (dollar)	109.74	116.80	92.41	88.99
Belgium (comm. franc)	5,385	5,837	4,535	4,447
Canada (dollar)	125.02	135.89	105.28	103.53
Finland (markka)	560.47	608.34	471.98	463.50
France (franc)	811.97	880.87	683.76	671.14
FRG (mark)	264.40	286.96	222.66	218.64
Italy (lira)	163,006	177,245	137,268	135,044
Japan (yen)	22,539	24,294	18,980	18,510
Netherlands (guilder)	297.90	323.67	250.86	246.61
South Africa (rand)	128.55	134.44	108.25	102.43
Spain (peseta)	15,015	16,127	12,644	12,287
Sweden (krona)	776.78	848.83	654.13	646.73
Switzerland (franc)	221.19	237.34	186.26	180.83
UK (pound)	70.27	75.76	59.17	57.72
US (dollar)	95.00	105.00	80.00	80.00

[1] Calculated using currency exchange rates published in the *Wall Street Journal* on June 29, 1984.

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CURRENT MARKET DATA

RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
3042A	1984	1,501-3,000	89	European Entity	US Utility	UF_6. Inventory purchase.
3042B	1990-97	1,501-3,000	indeterminate	European Entity	US Utility	
3004	1985	101-300	97	unknown	European Utility	UF_6. Seller probably a broker.
2997	1984	101-300	96-102	Canadian Producer	US Utility	
2993	1988-94	1,501-3,000	indeterminate	European Broker	US Utility	Seller-financed. Buy-sellback. Escalated base price.

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[1] Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.

Note: No secondary market transactions for enrichment services or conversion services are reported this month.

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URANIUM SUPPLY
(As of 6/30/84)

Nuexco™ Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
1575	—	500 per year	
1818	—	500 per year	1985-90
2134	220	—	
2201	95	—	
2236	—	200 per year	1985-89
2263	—	500 per year	1985-90
2275	145	—	
2288*	—	100	1985
2297	—	200 per year	1985-89
2336	—	250 per year	
2368	—	2,800	
2389	300	—	
2390	100	—	
2392	35	—	UF_6
2436A	850	—	enriched UF_6
2484	130	—	
2489	—	500	1986-90
2505	280	—	U_3O_8 or UF_6
2509	1,200	1,600	UF_6
2521*	50	100	U_3O_8 or UF_6
2557*	500	—	UF_6
2565	400	—	
TOTAL:	4,305		
INACTIVE			
0564	—	1,000 per year	1985-90
2191	125	—	UF_6
2193	—	800 per year	1986-90
2271	—	500 per year	1984-88
2326	—	3,500	1988-91
2429	450	—	
2473	—	500 per year	1984-90
2495*	130	—	UF_6
2514	—	1,000 per year	
2553	300	—	
TOTAL:	1,005		

* New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

Projects removed since last month: 2376, 2365, 2335, 2038, 2017.

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CURRENT MARKET DATA

URANIUM DEMAND
(As of 6/30/84)

	Delivery Period[1] (Thousands of Pounds U_3O_8)		
Nuexco Project Number	**Spot or Near-term[2]**	**Intermediate or Long-term**	**Remarks**
Inquiries to Purchase:			
ACTIVE			
2217	—	1,000 per year	1988-95
2329	—	500	1985
2352	240	—	
2355A	—	1,400	enriched UF_6
2419	60	—	UF_6
2456	650	—	UF_6
2494*	200	250	1985
2506*	60	—	U_3O_8 or UF_6
2558	235	—	UF_6
2566	500	—	
TOTAL:	1,945		
INACTIVE			
1999	—	50 per year	1985-90
2244	—	350 per year	
2372	—	250 per year	1985-88
2413	—	250 per year	1986-88
2414	—	150 per year	1987-91
2442*	—	250 per year	1986 on
2457	—	650	1987
2507*	—	300	1987-88
2528*	—	250 per year	1991 on
2542A	1,400	—	enriched UF_6
TOTAL:	1,400		

*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

Projects removed since last month: 2463, 2445.

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LOAN SUPPLY AND DEMAND
(As of 6/30/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8)		Remarks
	Within 1 Year	Beyond 1 Year	
Available for Loan:			
ACTIVE			
1938	2,000	—	UF_6
2128	2,500	—	
2139	2,000	—	
2483	550	—	
TOTAL:	7,050		
Inquiries to Borrow:			
ACTIVE			
2453	500	—	
TOTAL:	500		

Projects removed since last month: 2493.

CONVERSION SUPPLY AND DEMAND
(As of 6/30/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF_6)		Remarks
	Within 3 Years	Beyond 3 Years	
Available for Sale:			
ACTIVE			
2141	2,600	—	
2511*	225	—	
TOTAL:	2,825		
INACTIVE			
2051*	1,000	—	
2401	600	—	
2438	220	220	1985-87
2511*	330	330	1986-90
TOTAL:	2,150		
Inquiries to Purchase:			
INACTIVE			
2420	300	—	1986
TOTAL:	300		

*New or revised since last month.

[1] Measured from the date of this Report.

Projects removed since last month: 1936.

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CURRENT MARKET DATA

SWU SUPPLY
(As of 6/30/84)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
2100	—	100 per year	1986-87
2285	—	1,500	
2351	—	250	1986-88
2408	100	60	1986
2428	80	—	
2436B	225	—	enriched UF_6
2469	—	80	1987
TOTAL:	405		
INACTIVE			
2192*	—	210	1986-87
2345*	150	—	
TOTAL:	150		

*New or revised since last month.
[1] Measured from the date of this Report.
[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.
Projects removed since last month: 2510, 2378.

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SWU DEMAND
(As of 6/30/84)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2237	—	400 per year	1987-88
2355B	—	600	enriched UF_6
2432A	50	—	
2452	30	—	1985
2503	—	330	1986
2519	—	30 per year	1987 on
2522	20	—	
2544*	45	—	
2546*	30	—	
TOTAL:	175		
INACTIVE			
2407	75	130	1986
2432B	—	30 per year	1987 on
2443*	150	—	
2449	50	—	
2454*	75	75	1986
2459	50	50 per year	
2471	60	40 per year	
2479*	—	50	1986
2512	—	15 per year	1987 on
2518*	—	160	1987
2542B	340	—	enriched UF_6
2543	—	25 per year	1987 on
2550*	50	—	
2552*	35	—	
2567	—	45 per year	1987 on
TOTAL:	885		

*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

Projects removed since last month: 2520, 2475, 2448, 2412, 2400.

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COMMENTARY

DOE, ENRICHMENT POLICY, AND THE NATIONAL INTEREST

by **J.R. Wolcott,** *Chairman, Nuexco*

The US Department of Energy's (DOE) enrichment program has encountered numerous problems over the past few years. Setbacks to nuclear power growth have cut the requirements for enrichment services in half. Non-US customers have canceled many of their DOE contracts and chosen to purchase SWUs elsewhere in the world market. An active secondary market has reduced the near-term demand for primary services and heightened price competition. Declining revenues have threatened to make DOE's statutory requirement of full-cost recovery very hard to meet. DOE has come under fire from parts of Congress for alleged mismanagement.

DOE has endeavored to put a stop to these problems with a new contract that provides flexible terms and lower prices than DOE charged previously. It hopes that enough utilities will sign the contract to keep production volume high and maintain DOE's majority share of the world market (currently around 60 percent). It also hopes that revenues from those contracts, when combined with changes in certain accounting practices and the introduction of new technology, will keep its current program structure intact.

Need for Customer Concern

DOE's strategy should be considered closely by utility customers. DOE and its customers have a unique contractual relationship. Decisions on SWU prices, program costs, technology, and market strategy are made by DOE, approved by Congress, and passed on to customers. However, the Atomic Energy Act requires that all of the consequences of DOE's decisions be paid for in full by the customers. Payment may be delayed, because full-cost recovery is required only over a "reasonable period of time."

According to the US government's General Accounting Office (GAO), which reviewed DOE's current enrichment program for a Congressional committee, DOE could lose more than $3 billion over the next ten years. DOE disputes this assertion. Whether DOE or GAO is correct may not be known for some time, but the question should not be ignored. Legal compliance and individual accountability are involved. If GAO is right, a "cost bulge" is being pushed forward that DOE's customers must eventually swallow. Congress could eliminate it in some other way, but the national debt, the reluctance of Congress to subsidize nuclear power, and the trend towards increasing government revenues make that possibility doubtful.

Nationalism and Competition

The US government had a world monopoly on commercial enrichment supply 15 years ago. At the time, the government believed it had an obligation to make those services available to other nations. It also came to believe that it could use its monopoly for political ends, such as to control the production and use of enriched uranium generally. That worked for a while. However, the tendency of all nations to promote self-sufficiency in energy was a natural force against the continuance of the US government's monopoly. When the Atomic Energy Commission, DOE's predecessor, "closed the order books" in the early 1970s because of a perceived shortage of future production capacity, other nations were forced to look elsewhere for supply. The Urenco group formed in 1971, Eurodif formed in 1973, and European utilities began signing contracts with the USSR about the same time.

The US monopoly on enrichment supply was bound to be challenged. Today the market is highly competitive, and oversupply, rather than limited supply, is the problem. US government notions of establishing a DOE monopoly to control the supply of enriched uranium are not even faintly realistic. No competitive supplier even bothers to suggest such a motive for its own aggressiveness. The nationalism of most countries with regard to energy autonomy strongly suggests that the non-US market for DOE SWUs will continue to diminish.

DOE's Fading Export Market

The European market for enrichment services is not homogeneous, but most countries do lean strongly toward independence. Electricite de France, having the largest nuclear program on the continent, is probably the most nationalistic of DOE's potential European customers. Purchases will not be made from DOE mainly because the Eurodif plant is located in France, and the French national fuel cycle company Cogema is the principal shareholder in Eurodif. Eurodif prices are more favorable than DOE prices in any case. All of the other countries participating in Eurodif—Italy, Spain, and Belgium—also have a vested interest in its production and are thus unlikely to buy SWUs from DOE.

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The Federal Republic of Germany, Holland, and the United Kingdom all have Urenco production facilities within their borders, and majority ownership of each of those facilities is controlled by the national government or national industrial concerns. Close alliance exists between Urenco and the nuclear power industries in the three countries. Although there are several German utilities, few of which have vested interests in Urenco, the market for DOE is not favorable. Sweden and Switzerland, which together constitute about 5 percent of the world enrichment market, are participants in neither Urenco nor Eurodif. Both are neutral in their procurement practices; thus, if DOE's price is above the competition, the Swedish and Swiss utilities are unlikely to buy from DOE.

Europe is obviously a declining market for DOE. The growth of strongly competitive energy companies in nationalistic markets makes it difficult for outside entities to penetrate those markets, or hold their positions. In DOE's case, to capture and hold the European market would require pricing at ridiculously unprofitable levels.

The market in Japan, traditionally a DOE monopoly, is gradually changing. A few years ago the utilities began to diversify by contracting with Eurodif for a portion of their needs. Recently, a government-sponsored program for the development of commercial centrifuge enrichment capacity has led to construction on a demonstration plant capable of producing 200,000 SWUs per year. A utility-owned company will be formed to sponsor a larger commercial plant, and a preliminary site for that plant has recently been selected. The national goal is to produce at least one-third of Japan's enrichment needs by the year 2000.

Japan has an established history for industrial self-development. The process involves buying products from foreigners at the outset, developing domestic technology (often by purchase of technical licenses), establishing production capability, gradually building domestic production, and finally supplying all domestic needs. In the nuclear industry alone that has been the pattern for turbine-generators, steam supply systems, fuel fabrication plants, etc.

DOE will continue to be the largest supplier in the Japanese market for the short term. In the long term, however, DOE's prospects are not promising. Having limited indigenous resources, Japan seeks self-sufficiency. Its centrifuge process is similar to that used by Urenco. Once commercial production is demonstrated, there is little reason to believe that Japanese utilities will not expand to fill any needs not already covered by prior contracts. It would be a mistake for the USA to invest resources on the assumption that they would be used to supply a long-term Japanese market.

Other countries with nuclear power programs that are potential customers of DOE include Korea, Taiwan, South Africa, Brazil, and Argentina. Some of those potential customers have indicated plans to develop enrichment self-sufficiency in the long term, but most will buy competitively. The competitive market available to DOE is not large enough to have a major effect on policy.

DOE's Service Base: The US Market

The US market is biased towards DOE supply as other nations' utilities favor their domestic suppliers. But nations such as France, the UK, and Italy have only one nuclear utility, whereas the United States has approximately 60. Roughly half the US utilities insist upon domestic SWU supply; the remaining half need economic incentives to offset widely varying degrees of bias in favor of domestic supply.

DOE will probably retain 70 to 80 percent of the US market under any conditions. The remaining 20 to 30 percent will seek the most competitive supply terms, but there is ample reason to anticipate that DOE will remain the dominant long-term US supplier.

Enriched uranium inventories have accumulated over the past decade as a result of rigid supply contracts and drastic cutbacks to US utility nuclear power programs. An active secondary market has resulted and is probably at its peak. It will begin to ease as surpluses decline. A subsiding secondary market should be evident within 6 to 12 months.

Defining DOE's Purpose

From a business point of view, it is often difficult to understand government policies such as DOE's. Political, social and institutional considerations merge and intertwine and in doing so confuse what is *desirable* with what is *practical and economical*. Approval of DOE's policies rests with Congress. However, unlike business, in which the policies of management are subject to review and management bears the burden of proving the economic strength of those policies, Congress bears the burden of proving fault with DOE's policies.

An adversary relationship exists between DOE and some Congressional bodies. DOE usually presents a po-

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COMMENTARY

sition and provides minimal justification or explanation. Congress may be aided by the General Accounting Office (GAO) in its review. However, there are a multitude of Congressional Committees having overlapping responsibilities, and they do not function as a single body. Each has its own views and political interests. Antagonisms, empathy, cooperativeness, etc., vary from committee to committee and among legislators. The normal practice for a bureau such as DOE is to court the committee with the most influence over budget. In any case, the system does not operate like a business, simply because political and institutional solutions, which are the focus of government, override economic solutions, which are the focus of business.

Because of the many peculiarities of government, it is not always easy to determine what a policy is or even whether one exists. What is the purpose of the US government's enrichment program? Should DOE act as a national service (like the postal service)? A commercial business (like Urenco)? A political instrument (like a branch of the State Department)? A monopoly (as it once was)? All of these forms cannot be pursued simultaneously without conflicts and inconsistencies. For example, DOE will not achieve a satisfactory return on its investment if it cuts prices in an effort to regain a monopoly or enhance its control over nuclear proliferation.

DOE's only *practical* role in the existing market framework is that of an efficient national service. Such a role obligates DOE only to meet US needs and non-US contract obligations as they exist or are accepted. It does not obligate DOE to compete to maximize world market share, or to serve State Department ends. It does not obligate DOE to contradict itself by pressing for a monopoly on the US market in order to "preserve US energy independence"—while at the same time attempting to keep Japan or Taiwan dependent upon the USA. It does not obligate DOE to invest funds in facilities to supply services to non-US utilities.

If DOE's role is clarified, each of its programs can be judged by specific criteria, much as a business evaluates courses with respect to profitability. A clear definition of mission would enable Congress and the Executive Branch to work from a common starting point.

Policy Choices

In fulfilling its role DOE faces two key policy choices:

1. Whether to follow an *offensive* or a *defensive* marketing strategy;
2. Whether to be a price *follower* or a price *leader*.

In addition, it must determine the appropriate role of research and development and the degree to which its current operations need fundamental restructuring.

Any business in crisis, as DOE views itself, has to choose between an offensive and a defensive strategy. An offensive strategy may be defined as one in which DOE attempts to enlarge its market share, obtain new non-US contracts, and sustain a near-monopoly position in the USA. A defensive strategy may be defined as one in which DOE reduces its size and ambition to the lowest limit possible that still serves the national interest, and then allows economics alone to determine expansion and investment.

Normally price stability in a concentrated industry such as the enrichment market is achieved when one participant is recognized as the price leader and others adjust their prices accordingly. The price leader is usually the least vulnerable. When the leader is also the highest-cost producer, as DOE is, the followers profit by settling for a reasonable market share under the leader's umbrella. The strength of the price leader is the security of its market base and its lack of desperation.

If DOE followed a defensive strategy, it would formulate policies according to national interest rather than the actions of the competition, and it would remain a price leader. Eurodif, Urenco and the USSR would follow DOE's lead, as they have in the past, or they would compete among themselves. If DOE chooses to be a price follower by attempting to match low prices offered by other enrichers, chaos will result. At the moment DOE appears much more concerned with "price followership" than "price leadership."

New Technology Is Not Necessarily a Solution

DOE is the world's highest cost and highest volume enrichment producer, and it has the largest available production capacity—followed by Eurodif, the USSR and Urenco. Presently Urenco is the only enricher employing centrifuge technology for commercial purposes. DOE's planned centrifuge program (GCEP) is much grander than the Urenco program—based largely, perhaps, on the old philosophy that big is beautiful.

Currently a large portion of the DOE enrichment program budget is marked for the development of new technologies. The main reason is that DOE expects new technology to give it a competitive cost advantage, that the cost advantage will lead to a price advantage, and that the price advantage will lead to market gains. Even if the goal of gaining market share were desirable in terms of the US national interest, it is not clear that competitive conditions support the reasoning. Both Eurodif and the

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USSR use the gaseous diffusion process employed by DOE, and both have substantially lower volumes, ranging from one-third to one-tenth that of DOE. Both nevertheless price their services well below DOE and claim that low costs would enable them to match any DOE price. A change in technology may not resolve DOE's problems.

This does not suggest that research and development is not worthwhile. It does suggest that factors other than technology play an important, perhaps decisive, cost and pricing role. DOE's cost problems may be structurally embedded such that they will not be solved by changing technology or by increasing volume. A new technology employed in the same political and institutional framework may leave DOE in about the same position. Similarly, an institutional restructuring might place DOE in a competitive position using the 27 million SWUs of existing gaseous diffusion capacity, and thus allow for more relaxed GCEP and AVLIS schedules. Answers to questions about the institutional structure and costs of DOE should be sought to find out if DOE is attempting to solve institutional or political problems with a technological solution.

Comparative Cost Structures

DOE operates three gaseous diffusion plants in three locations. By far the largest element of cost for all three is power. Approximately two-thirds is supplied by the Tennessee Valley Authority (TVA), with the balance by private utilities. For various contractual reasons, TVA's power charges are approximately two times those of private companies. During the forthcoming year, DOE will pay approximately $100 per SWU for power costs alone, though it will charge its customers only $67 per SUW for power. The lesser figure is derived by using low-cost SWU taken from inventory. During 1984 approximately 15 million SWUs will be delivered, but only 10–12 million will be produced.

The GCEP plant, if completed as proposed, will cost $6.5 to $7.5 billion and will have the capacity to produce approximately 13 million SWUs per year. While the power requirement will be on the order of 10 percent that for diffusion, high fixed charges will have to be borne regardless of volume.

SWU production has to be viewed comprehensively as a combined system in which power plays a major part. Gaseous diffusion provides one economic structure; centrifuge technology another. An important difference exists between fixed and variable charges. A high fixed-charge system, such as GCEP, needs firm, fixed loading to be economical. A high variable-cost system can accommodate changing markets. Furthermore, in a choice between investing in a general-purpose facility (such as the power generation plants required to service the gaseous diffusion technology) or a special-purpose facility (such as the centrifuge machines for GCEP), a sound business approach would favor the former.

Eurodif has taken the former approach. Several billion dollars were invested in four nuclear power units to supply cheap power to the diffusion plant. The effect of this was to place investment on the power generation side, rather than on the separation plant side, resulting in two advantages.

1. The heavy investment is multi-purpose. When SWU production does not require use of facilities, electrical energy can be sold to the French grid. The combined separation plant and nuclear plant system constitutes a high variable-cost, low fixed-cost system.
2. Investment can be depreciated over a longer term (perhaps 30 years) because new technologies do not threaten to make the nuclear power obsolete. A GCEP plant investment, on the other hand, is vulnerable to technology advances, such as laser technology. A 10-year depreciation period may be realistic.

The form of enrichment system comparison described above is only one of several that exist. The example illustrates that employing the most "advanced" technology may not be a practical solution to structural problems.

Conclusions

DOE should not be optimistic about gaining or even maintaining its share of the non-US enrichment market. Instead, it should redefine its role in the enrichment market to serve the US national interest. Specifically:

1. It should pursue a defensive, rather than an offensive, strategy;
2. It should concentrate on serving the US market as a government service;
3. It should restructure competitively using the present technology. A clearer understanding is needed of the costs and benefits associated with new technologies.

DOE's course of action should be of increasing concern to utilities. If, as GAO predicts, aggressive pricing, technological development and facility investment policies do not produce the results DOE hopes for, US utilities eventually may be required to pay the bill.

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URENCO

Introduction

The governments of the United Kingdom, the Federal Republic of Germany, and the Netherlands created the basis for Urenco in March 1970, when representatives from each country signed an agreement at Almelo, the Netherlands, to coordinate their national centrifuge enrichment projects. Today, Urenco is the only one of four commercial uranium enrichment enterprises that uses gas centrifuge technology; the other three enrichers, Techsnabexport, Eurodif, and the US Department of Energy (DOE), operate gaseous diffusion plants. (Japan's Power Reactor and Nuclear Fuel Development Corporation (PNC) is building a centrifuge enrichment demonstration plant, but it is not scheduled to begin SWU production until 1987.)[1] Urenco is marketing its services aggressively, and has made highly competitive contract offers due to the cost advantages inherent in the centrifuge process and plant design.

Ownership Structure

Urenco can be described as a federation of centrifuge enrichment enterprises brought together to benefit from the coordination of research, investment, and sales. The marketing agent and managing company of the group is Urenco Ltd., headquartered in the UK and owned one-third each by BNFL, UCN, and Uranit (see Figure 1 for full company names). Although centrifuge research is carried on in all three countries, the principal research and development company of the group is Centec, headquartered in the FRG and owned one-third each by BNFL, UCN and GNV. BNFL owns and operates one Urenco enrichment plant at Capenhurst in midwest England, the site of the UK Atomic Energy Authority's now-retired gaseous diffusion plant. UCN and Uranit share ownership of a second, larger plant at Almelo, and Uranit is building a third facility at Gronau, FRG, just across the border from Almelo (Figure 2).

Plant Capacities

At the time Urenco was incorporated, BNFL was constructing a pilot-scale centrifuge plant at Capenhurst, and German and Dutch teams simultaneously were building two pilot plants at Almelo. The machines in those pilot plants were small and the result of largely independent design work, and thus constituted a mixed first generation for the group as a whole. The results of independent efforts were combined gradually thereafter. Urenco received its first commercial enrichment contract in 1974, and construction began in that year on two commercial demonstration plants, one at Capenhurst and one at Almelo, each having a planned annual capacity of 200,000 SWUs. Installation of the first of four halls of second-generation centrifuge machines was completed in both plants in the Fall of 1977. Each hall (Figure 3) contained eight cascades. Both demonstration plants reached full production capacity in 1980.

Figure 4 is a recent aerial view of the Almelo plant site. Since the completion of the demonstration plants, Urenco has added plant capacity at both sites on a modular basis to meet its growing delivery commitments. The addition of 200,000 SWUs of capacity at Capenhurst, and 400,000 SWUs of capacity at Almelo began in 1980 and was completed in 1983, at which time further expansion was initiated. Urenco's total annual production capacity in 1982 approximated 900,000 SWUs, increasing to over 1 million SWUs in 1983. Construction at the 80-hectare (200-acre) Gronau site began in mid-1982; plant buildings there are now complete, and installation of a third generation of centrifuges has begun. Urenco projects a total annual production capacity of 3 million SWUs in 1990 and 4.5 million SWUs in 1995, at which time each of the three plants will have the capacity to produce 1.5 million SWUs a year.

Feed and Product Handling

The allocation among plants of SWU deliveries is managed by Urenco Ltd. Upon arrival at a plant site, natural UF_6 is weighed, sampled, and put in temporary storage. Feed is moved as needed to a station in the main process building, where it is loaded into an autoclave and connected to a feed manifold. Over a period of 24 hours, steam heats the container to 70–80 degrees Celsius. When the stop valve of the container is opened, the liquid hex vaporizes and flows from the feed manifold through the main feed distribution system of the plant.

The feed distribution main connects to individual cascades within an operational module of the plant via isolation and flow control valves. Thus, cascades can be disconnected from the system selectively. Each cascade yields product and tails streams having enrichment and depletion levels coordinated for the module. The streams feed into collective product or tails de-sublimers, which, at low pressure and a temperature of approximately –70

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[1] See page 21 of Report 185 for an article on *US DOE Gaseous Diffusion Plants;* page 26 of Report 188 for an article on *Eurodif;* and page 29 of Report 189 for an article on *Uranium Enrichment in Japan.*

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degrees Celsius, cool and solidify the UF_6. When a desublimer is full, it is isolated from the module and heated; UF_6 gas is then transferred via pipelines to a central handling area. There, after weighing, analysis, and blending if necessary, enriched product is condensed into containers for shipping.

Production Commitments and Marketing

More than half of Urenco's current services are provided through BNFL to the UK's Central Electricity Generating Board (CEGB), as indicated in Table 2. Contracted deliveries to German utilities will take an increasing share of production over the next few years. Up to now, Urenco has not met with notable success in marketing its services outside of Europe, or more generally, outside of the three countries participating in the enrichment venture. Recently, however, the company has stepped up efforts to sell SWUs in the USA and the Far East. It hopes to gain sales to committed DOE customers that are able, under the terms of the USEC, to purchase 30 percent of enrichment requirements abroad.

Moreover, Urenco hopes to lure traditional customers of DOE away from the USA altogether. In competition with both primary enrichers and secondary market SWU sellers, Urenco has offered prices equivalent to around 60 percent of the $135 USEC price. There are several explanations for the company's ability and willingness to price its services at such low levels.

1. Unlike any of its competitors, Urenco has controlled investment in plant production capacity to correspond with actual delivery commitments. Existing facilities have operated at close to 90 percent of capacity, as compared with less than 60 percent for Eurodif and approximately 40 percent for DOE.

2. Centrifuge enrichment involves certain inherent cost advantages over gaseous diffusion, not the least of which is a lower power requirement. Urenco claims to expend a plant total of approximately 80 kwh per SWU at its facilities, which is less than 5 percent of the power requirement for operating gaseous diffusion plants.

3. Urenco's centrifuge machines have demonstrated a machine failure rate of less than 0.5 percent. Because the group has developed relatively small centrifuges (the third generation machines have capacities of around 50 SWUs per year), those machines that do fail do not interrupt cascade operation.

4. Undoubtedly the Urenco group is offering low SWU prices primarily to attract customers, and thus gain the opportunity to establish international credibility.

Table 2

**NUEXCO ESTIMATE
OF URENCO DELIVERY COMMITMENTS
(Millions of SWUs)**

Country	'83	'84	'85	'86	'87	'88	'89	'90
UK	0.58	0.71	0.83	0.86	0.86	0.86	0.86	0.85
FRG	0.37	0.51	0.76	0.58	1.07	1.10	1.25	1.17
Other	0.01	0.01	0.06	0.39	0.48	0.34	0.47	0.47
TOTAL	0.96	1.23	1.65	1.83	2.41	2.30	2.58	2.49

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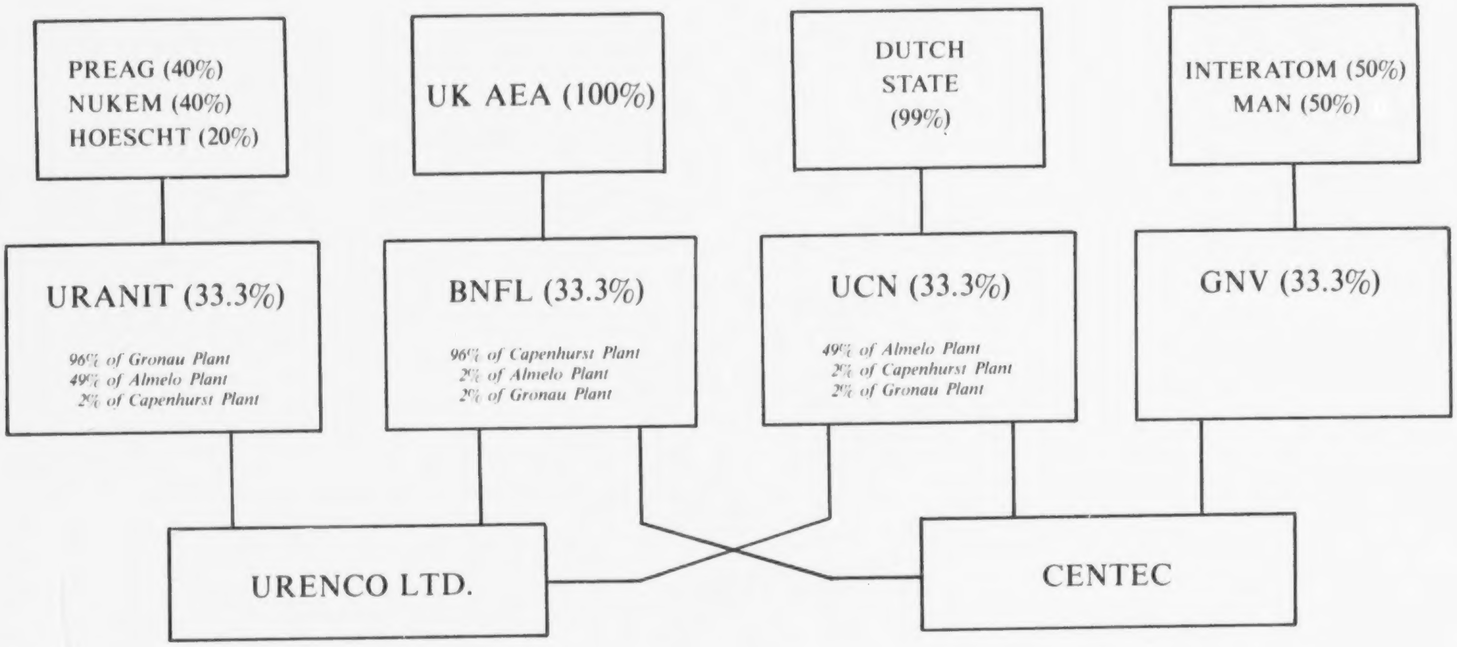
Figure 1

OWNERSHIP STRUCTURE OF URENCO GROUP


PREAG (40%)
NUKEM (40%)
HOESCHT (20%)
UK AEA (100%)
DUTCH STATE (99%)
INTERATOM (50%)
MAN (50%)
URANIT (33.3%)
96% of Gronau Plant
49% of Almelo Plant
2% of Capenhurst Plant
BNFL (33.3%)
96% of Capenhurst Plant
2% of Almelo Plant
2% of Gronau Plant
UCN (33.3%)
49% of Almelo Plant
2% of Capenhurst Plant
2% of Gronau Plant
GNV (33.3%)
URENCO LTD.
CENTEC

BNFL —British Nuclear Fuels Ltd. PLC
CENTEC—Gesellschaft fuer Centrifugentechnik mbH
GNV —Gesellschaft fuer Nukleare Verfahrenstechnik mbH
MAN —Maschinenfabrik Augsburg-Nuerenberg AG

PREAG —Preussenelektra AG
UCN —Ultra-Centrifuge Nederland NV
UKAEA —United Kingdom Atomic Energy Authority
URANIT—Uran-Isotopentrennungsgesellschaft mbH

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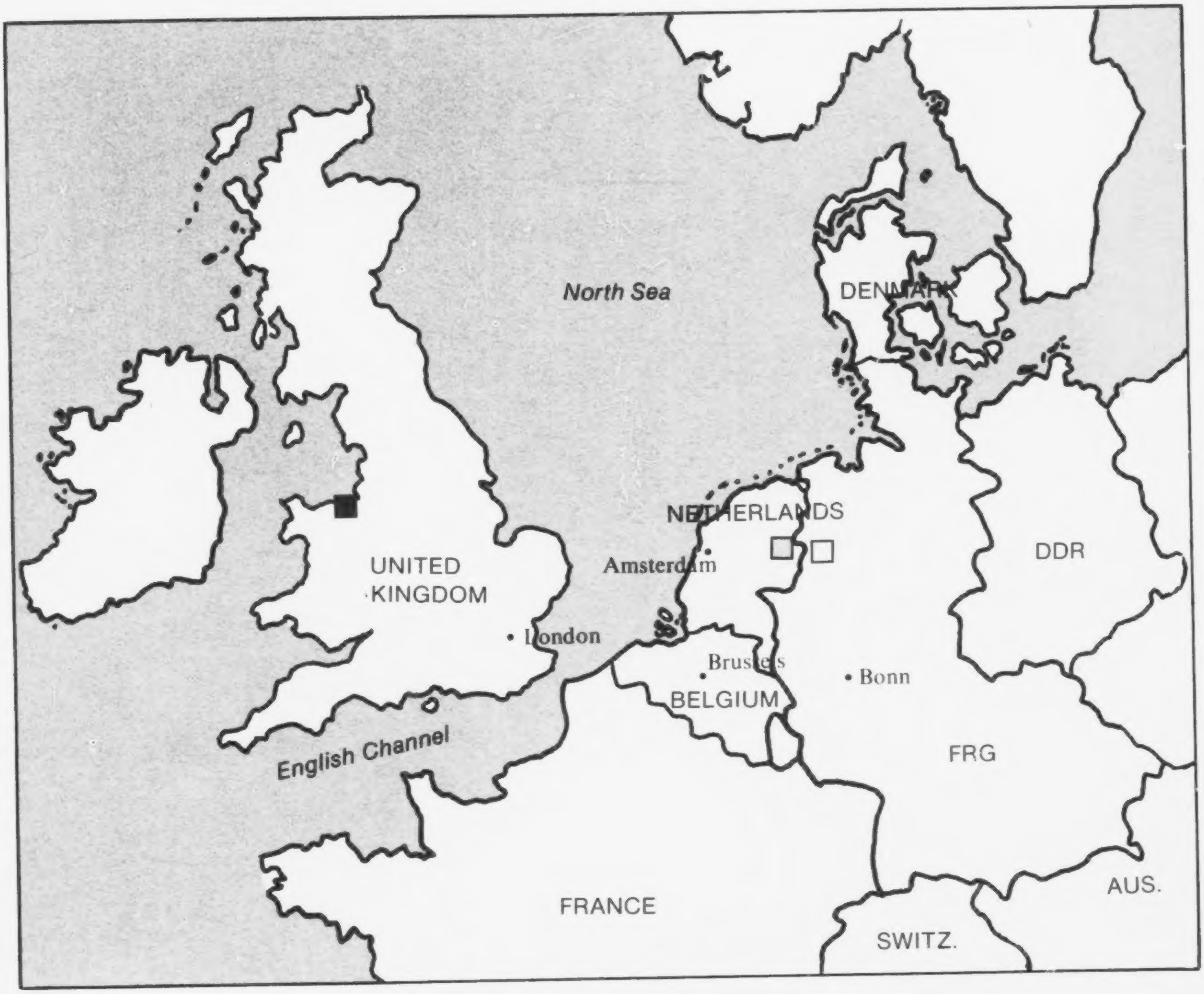
Figure 2

URENCO PLANT LOCATIONS


North Sea
DENMARK
UNITED KINGDOM
London
NETHERLANDS
Amsterdam
Brussels
BELGIUM
Bonn
DDR
FRG
English Channel
FRANCE
SWITZ.
AUS.

■ Capenhurst Plant Site (UK)

▨ Almelo Plant Site (Netherlands)

☐ Gronau Plant Site (FRG)

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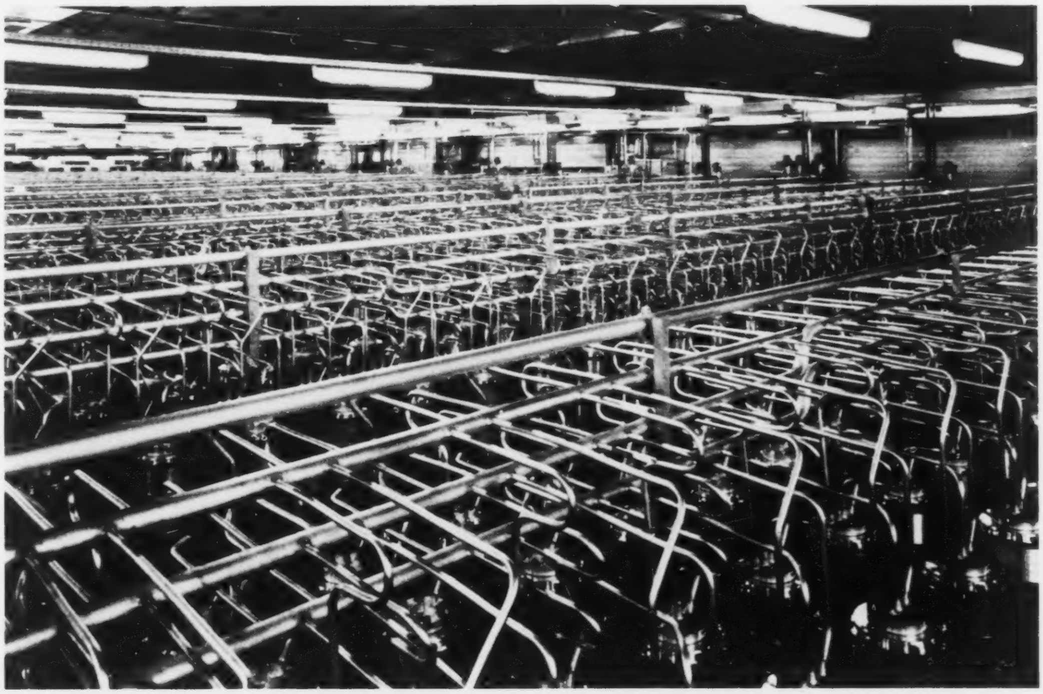

Figure 3. Centrifuge enrichment cascades.

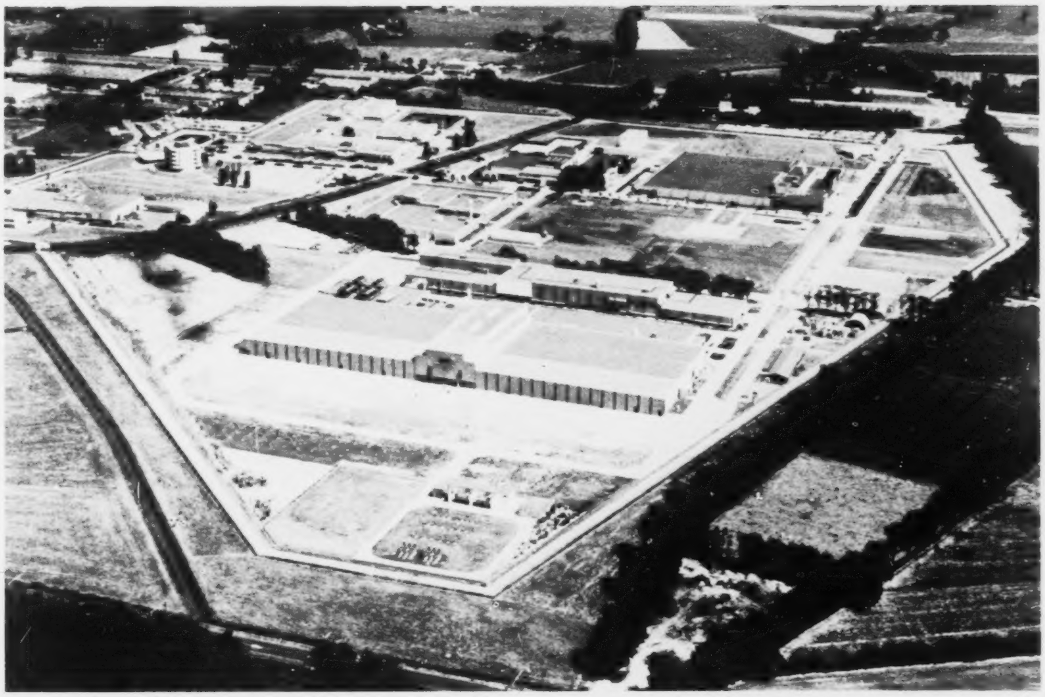

Figure 4. Aerial view of Almelo plant.

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JAPAN

Japan's Federation of Electric Power Companies (FEPC) has announced a site proposal for commercial-scale enrichment, spent-fuel storage, and reprocessing facilities. The location is in the Mutsu-Ogawara area of Aomori Prefecture, on the Shimokita Peninsula, on the northern end of Japan's main island of Honshu. An alternate proposal locates the enrichment and waste storage facilities in the Mutsu-Ogawara area, and the reprocessing facility at Higashidori, 30 kilometers to the north. Local and national governments had designated the Mutsu-Ogawara area for industrial development prior to the FEPC proposal; Higashidori was already designated a future nuclear power plant site.

The timing of the FEPC proposal was somewhat unusual. Normally announcements of preliminary nuclear-related plant sites are preceded by detailed planning and discussion with local interests. The FEPC announced its proposal prior to conducting the usual amount of preparatory work. However, the prefectural response has been favorable. Following the announcement, the prefectural governor met with national government officials to solicit cooperation in the implementation of the plan. Investment in the three facilities is likely to exceed $4 billion. Thus, the proposal promises industrial growth for a relatively underdeveloped region in Japan.

Plant siting, particularly for waste storage and reprocessing facilities, has been a major obstacle to completion of the nuclear fuel cycle in Japan. Most spent fuel is currently stored on-site, though a portion is shipped to France and the UK for reprocessing. PNC (Power Reactor and Nuclear Fuel Development Company) currently operates a demonstration reprocessing plant and is building a demonstration enrichment plant. Those plants are likely to be prototypes for the commercial facilities proposed for the Shimokita Peninsula. The utilities and related industrial concerns organized Japan Nuclear Fuel Services Company (JNFS) in 1980 to construct and operate the commercial reprocessing plant, planning for 1000 tons U per year capacity in the early 1990s. If the FEPC site proposal is approved and all three fuel cycle facilities are located in one place, JNFS may also adopt the commercial enrichment enterprise, for which an annual capacity of 1 million SWUs is hoped by 1995.

Table 3

FY 1983 GENERATING STATISTICS, JAPAN

Electric Power Company	Generating Capacity (GWe)[1]			FY83 Generation (GWh)		
	Total	Nuclear	Percent Nuclear	Total	Nuclear	Percent Nuclear
Chubu	17.39	1.38	7.9	71,880	8,586	11.9
Chugoku	7.78	0.46	5.9	25,037	2,833	11.3
Hokkaido	3.74	—	—	16,820	—	—
Hokuriku	3.61	—	—	12,171	—	—
Kansai	24.49	5.67	23.2	92,793	34,371	37.0
Kyushu	9.96	1.12	11.2	37,543	9,167	24.4
Shikoku	5.08	1.13	22.2	18,987	8,473	44.6
Tohoku[2]	8.02	—	—	35,882	597	1.7
Tokyo[3]	34.63	5.80	16.8	143,348	38,960	27.2
TOTAL[4]	114.70	15.56	13.6	454,461	102,987	22.7

[1] Installed capacity at beginning of FY 1983 (April 1, 1983). The Japan FY83 ended on March 31, 1984.

[2] Tohoku EPC's Onagawa unit 1 (524 MWe) began preliminary operations in FY83, and commercial operation is scheduled for later this year.

[3] Tokyo EPC's Fukushima unit II-2 (1100 MWe) operated during much of FY83 and began commercial operation in February 1984.

[4] Does not include Japan Atomic Power Company's 1,623 MWe of nuclear generating capacity or 10,135 GWh of nuclear-generated electricity in FY83.

Source: Japan Atomic Industrial Forum.

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RECENT DEVELOPMENTS

Table 3 presents recently released generating statistics for FY 1983 (ending March 31, 1984) for Japan's nine regional electric power companies. Nuclear power provided more than 22 percent of total megawatt hours generated by the nine utilities, while the utilities' 21 commercially operating units accounted for only 13.6 percent of total generating capacity.

Currently there are 25 units in commercial operation in Japan. Tokyo EPC's Fukushima unit II-2 began commercial operation in February of this year, and Tohoku EPC's Onagawa unit 1 is near commercial operation. While the capacities of those two units are not included in the totals presented in Table 3, power generated by them is. Japan Atomic Power Company's (JAPC) three units are not included in the analysis presented in Table 3, though electricity from those units is wholesaled to the nine electric power companies. The nine utilities supply over 80 percent of Japan's electricity needs.

Japan's 25 commercial units achieved an average capacity factor in FY83 of 71.5 percent, a record. Table 4 lists average capacity factors over the past decade. Low capacity factors in earlier years were the result primarily of technical problems encountered worldwide with BWR and PWR plant designs. Design improvements, along with reductions in maintenance and refueling down-time, have resulted in steady improvement of plant efficiency.

Table 4

HISTORICAL AVERAGE CAPACITY FACTORS, JAPAN

Year	Number of Units	Average Capacity Factor
1974	8	54.8
1975	12	42.2
1976	13	52.8
1977	14	41.8
1978	19	56.7
1979	21	54.6
1980	22	60.8
1981	23	61.7
1982	24	67.6
1983	25[1]	71.5

[1] Includes 13 BWRs, 11 PWRs, and one GCR.

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CENTRAL AFRICA

Uranium operations in Gabon and Niger produced a total of approximately 11.5 million pounds U_3O_8 in 1983, some 12 percent of total free world production. Almost all of that amount remained in the hands of the owners of the three operating production projects. The French government administered Gabon and Niger prior to their independence in August 1960; African national entities and French companies now control most of the uranium interests. Production costs are relatively high because of the combination of low average ore grade and long, variable transportation lines. Nuexco had predicted in 1983 that future output from both countries would be reduced greatly, but cutbacks for the near term have been moderate, in part because of long-term supply agreements that are not related to spot market prices.

Gabon

The Mounana mill, located approximately 50 kilometers northwest of the city of Franceville in the Upper Ogooue River region of east Gabon (Figure 5), processes all of the ore extracted from the nearby Oklo and Boyindzi deposits. Those deposits have average grades of 0.3 to 0.4 percent U_3O_8. Open-pit mining has been active at Oklo since 1970, while underground mining of a large extension began in 1977. An underground mine to exploit the Boyindzi deposit has been producing ore since December 1980. A new mill began operating at Mounana in mid-1982, having the capacity to process 440,000 tonnes ore per year. U_3O_8 output totalled approximately 2.6 million pounds in 1983, roughly 70 percent derived from Oklo and 30 percent from Boyindzi.

The owner of the project is Comuf (Compagnie des Mines d'Uranium de Franceville); it leases a 1,150 square kilometer concession area originally granted by the government of Gabon to the French CEA (Commissariat a l'Energie Atomique). The ownership of Comuf is listed in Table 5; major owners are Compagnie Francaise Mokta (39 percent), the Gabonese state (24.8) percent, Cogema (18.8 percent), and Pechiney (13.0 percent). Mokta, a subsidiary of the Imetal group, is the operator of the project. Cogema takes the majority of the output from Mounana, with other European and Japanese buyers receiving deliveries from short and medium-term contracts. Comuf receives in the neighborhood of $30-35 per pound U_3O_8 from its buyers. Comuf, Cogema, and Kepco (Korea Electric Power Company) are involved in detailed exploration programs in and around the existing concession area.

Gabon is approximately two-thirds the size of the country of France and has a population of 1.2 million. The French government recently agreed to sell the Gabonese government a small research reactor to help develop the country's educational and industrial base. A wealth of indigenous resources (primarily oil) have given Gabon the highest per capita GDP in Africa after Libya. Uranium accounts for approximately 7 percent of export earnings. A substantial portion of state revenue is currently spent on the Transgabonais railway, which will link the interior of the country to the coast. The northern half of the railway has been completed, and the link to Franceville is likely to be finished by the end of this decade. Currently it takes several days for concentrates to get from Mounana to ocean ports in Gabon or the Congo.

Table 5

OWNERSHIP OF COMUF[1]

Company	Percent Ownership
Mokta[2]	39.0
Gabon State	24.8
Cogema[3]	18.8
Pechiney	13.0
Other	4.4

[1] Comuf = Compagnie des Mines d'Uranium de Franceville.
[2] Mokta = Compagnie Francaise Mokta.
[3] Cogema = Compagnie Generale des Matieres Nucleaires.

Niger

The two projects currently producing uranium in Niger, Akouta and Arlit, are both located approximately 250 kilometers northwest of Agadez and 80 kilometers west of the Air Mountains, in central Niger (Figure 5). Akouta is ten kilometers south of Arlit; between them, and within the same concession area belonging to the CEA, is the Tassa N'Taghalgue deposit, which has been undergoing development since 1981. Niger owns shares in all of the uranium projects through the state company Onarem (Office National des Ressources Miniere).

The underground operation at Akouta began production in mid-1978. Mill output during 1983 totalled 5.2 million pounds, 58 percent of Niger's total for the year. The project owner is Cominak (Compagnie Miniere d'Akou-

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ta); its shareholders, listed in Table 6, are Cogema (34 percent), Onarem (31 percent), Japan's Overseas Uranium Resources Development Company (25 percent), and Enusa (Empresa Nacional del Uranio SA) (11.9 percent). Production distribution is reviewed annually. Output this year may be reduced by up to 30 percent due to lack of demand from Cominak's shareholders. Cogema is the operator and currently purchases approximately half of the output.

The Arlit project involves open-pit mining of three related sedimentary deposits, with ore processed in two operating mill units—one of which began production in 1971 and the other in 1980. Arlit produced 3.7 million pounds in 1983. The project owner is Somair (Societe des Mines de L'Air); its principal shareholders (Table 6) are Onarem (33 percent), Cogema (27 percent), and Mokta (19.4 percent). Cogema is the project operator. For reasons similar to those affecting Cominak, production cutbacks at Arlit of up to 40 percent have been discussed recently.

Niger is a large, predominantly desert country having a population of 5.5 million. A 400-mile road connecting the Air uranium district to Tahoua, in the more populous southern belt of the country, was first paved in the late 1970s. Uranium shipments must travel more than 2,000 kilometers from the mill to shipyards at Cotonou on the Gold Coast; at current exchange rates, transport costs add approximately $3 per pound to the price of Niger's U_3O_8 exports. Uranium accounts for some 70 percent of Niger's export earnings. Currently Onarem is waiving its option to purchase U_3O_8 from Cominak and Somair because of a lack of demand in the world market. In the past, the state company has sought uranium trade arrangements with developing Islamic nations, including Pakistan, Libya and Egypt.

Table 6

OWNERSHIP OF COMINAK[1] AND SOMAIR[2]

	Company	Percent Ownership
Cominak		
	Cogema[3]	34.0
	Onarem[4]	31.0
	OURD[5]	25.0
	Enusa[6]	10.0
Somair		
	Onarem	33.0
	Cogema	27.0
	Mokta[7]	19.4
	Pechiney	7.6
	Urangesellschaft GmbH	6.5
	Agip Uranio	6.5

[1] Cominak = Compagnie Miniere d'Akouta.
[2] Somair = Societe des Mines de L'Air.
[3] Cogema = Compagnie Generale des Matieres Nucleaires.
[4] Onarem = Office National des Ressources Miniere.
[5] OURD = Overseas Uranium Resources Development Co. (Japan).
[6] Enusa = Empresa Nacional del Uranio SA (Spain).
[7] Mokta = Compagnie Francaise Mokta.

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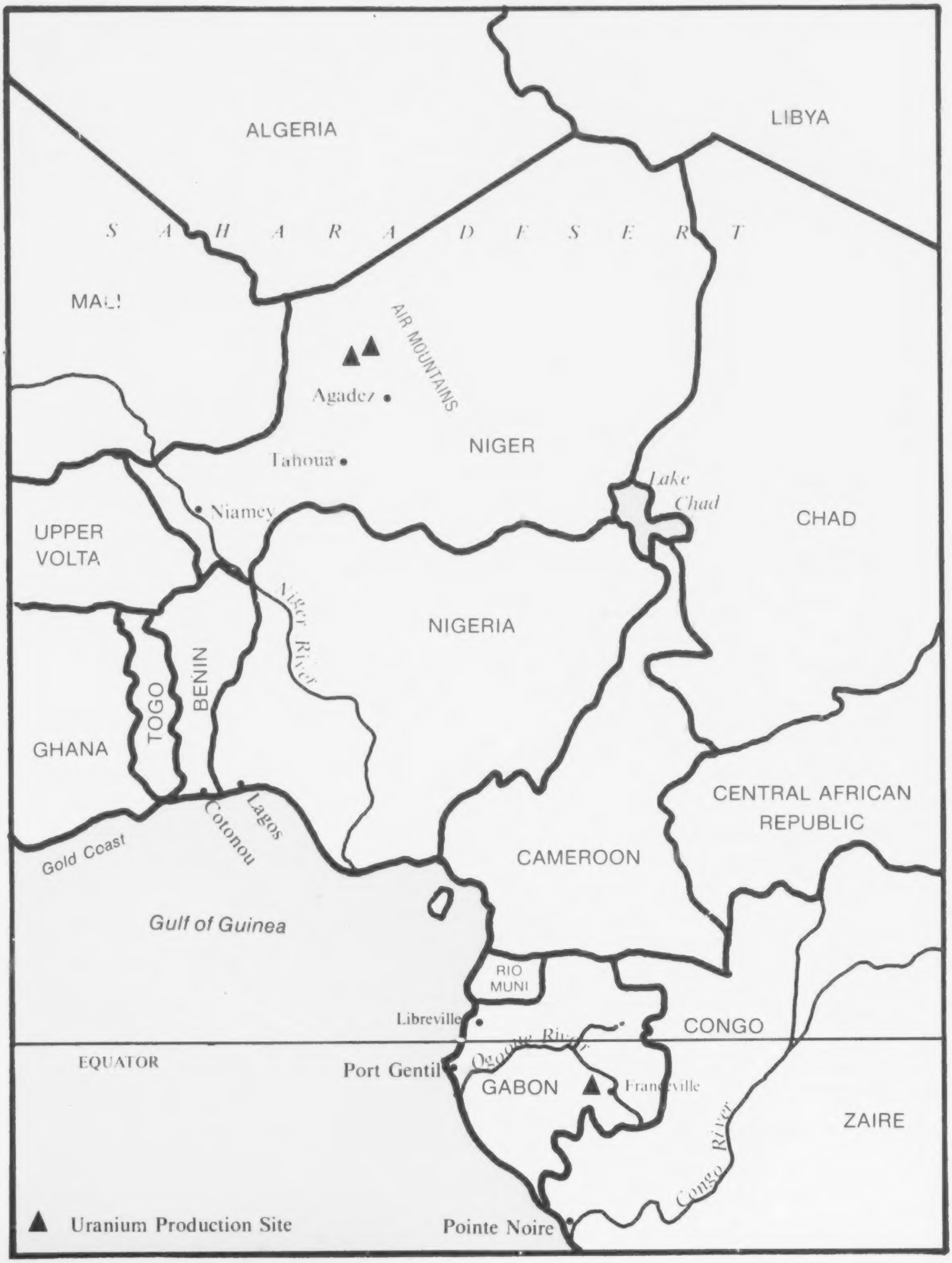
Figure 5

CENTRAL AFRICA


ALGERIA
LIBYA
SAHARA DESERT
MALI
AIR MOUNTAINS
Agadez
NIGER
Tahoua
Lake Chad
Niamey
CHAD
UPPER VOLTA
Niger River
NIGERIA
TOGO
BENIN
GHANA
CENTRAL AFRICAN REPUBLIC
Lagos
Cotonou
Gold Coast
CAMEROON
Gulf of Guinea
RIO MUNI
Libreville
CONGO
Ogooue River
EQUATOR
Port Gentil
GABON
Franceville
ZAIRE
Congo River
▲ Uranium Production Site
Pointe Noire

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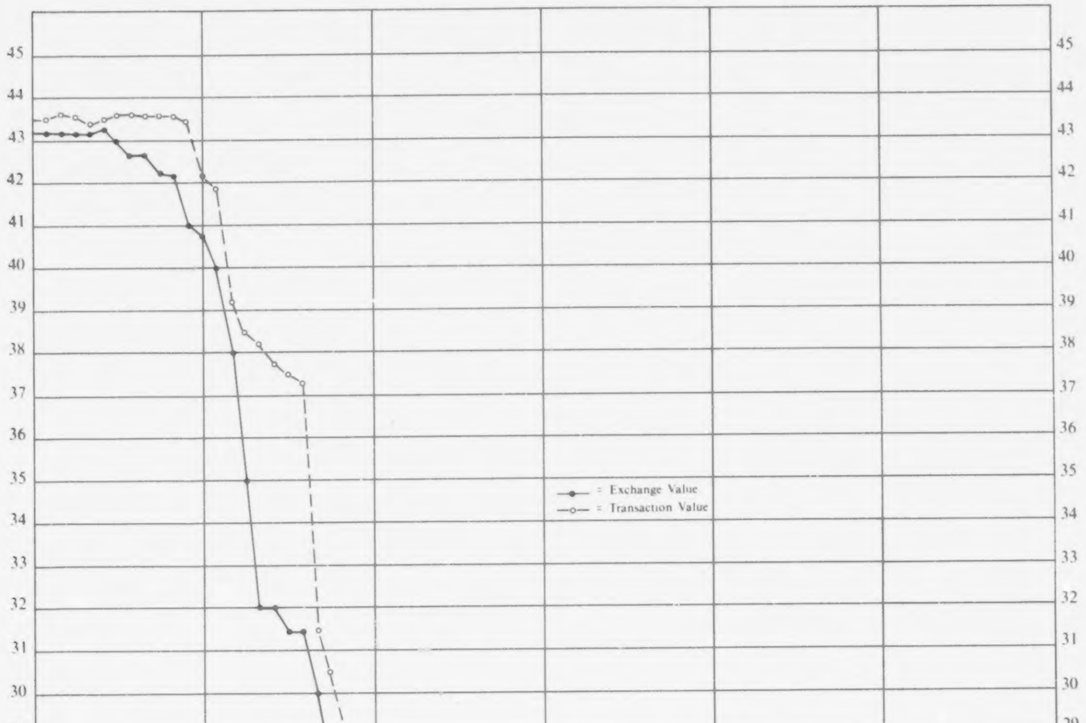
HISTORICAL MARKET DATA

EXCHANGE AND TRANSACTION VALUES SINCE JANUARY 1979

Determined as of the last day of the month indicated



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HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	32.50	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00
1984	20.50	17.50	17.00	17.75	17.75	**17.50**						

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85
1984	23.05	22.50	19.25	17.90	17.00	**16.50**						

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60
1984	0.60	0.30	0.80	0.80	0.80	**0.00**						

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GOVERNMENT STATISTICS

AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage Earners, Weekly Rates[2] (1976=100)
1983 Avg.	401.2R	181.8
Apr 1983	407.3R	180.1R
May 1983	414.7R	180.1
Jun 1983	415.6R	180.2
Jul 1983	408.4R	179.9
Aug 1983	403.1R	179.9
Sep 1983	403.1R	179.8
Oct 1983	397.6R	187.5R
Nov 1983	395.7R	187.5R
Dec 1983	399.3R	187.3R
Jan 1984	399.2R	187.5R
Feb 1984	402.4	187.3R
Mar 1984	403.9	187.1R
Apr 1984	—	194.8

CANADA

		Wage-earner Data: Average Hourly Earnings (C$)[2]					
	Industry Selling Price Index: Manufacturing[1] (1971=100)	Uranium Mines (SIC 057)	Metal Mines (SIC 051-059)	Mines, Quarries and Oil Wells[3] (SIC 051-099)	Primary Metal Industries Non-ferrous[4]		Chemicals and Chemical Products[5] (SIC 370-379)
					(SIC 296)	(SIC 298)	
1983 Avg.	298.8	—	14.69	14.30	—	—	11.17
Jun 1983	299.3	17.02	14.60	14.07	11.33	9.84	11.05
Jul 1983	300.4	16.48	14.35	13.93	11.70	9.83	11.04
Aug 1983	301.3	16.93	14.36	13.89	11.82	10.08	11.19
Sep 1983	301.1	17.66	14.90	14.41	11.99	10.32	11.29
Oct 1983	301.6	17.73	15.27	14.65	11.76	10.03	11.30
Nov 1983	301.8	17.82	15.29	14.67	11.78	10.62	11.38
Dec 1983	302.9R	17.84	15.11	14.66	11.86	10.60	11.51
Jan 1984	305.3R	17.74	15.27	14.74	11.91	10.84	11.69
Feb 1984	306.5R	17.78	15.59	14.90	12.04	10.82	11.51
Mar 1984	308.7	18.05	15.52	14.82	12.14R	10.84R	11.58
Apr 1984	310.3	—	—	—	—	—	—
May 1984	310.6	—	—	—	—	—	—

P = Preliminary R = Revised since last month

For annual averages prior to 1983, and for notes pertaining to these statistics, see pages 23–26 of Report 190 of June 1984.

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REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per per Metric Ton of Gold Ore Milled (Rand)[1]	Tonnage-Weighted Index of Average Working Costs per Metric Ton of Gold Ore Milled (March 1982=100)[2]	Consumer Price Index[3] (1975=100)[4]	Producer Price Index All Groups[5] (1975=100)	Total Employment in Mining and Quarrying (Code 35)[6]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[6]
1983 Avg.	51.87	115.0	262.2	274.8	696,579	3,644,772
Jul 1983	—	—	262.5	273.7	704,202	314,566
Aug 1983	—	—	265.6	278.9	698,984	311,789
Sep 1983	52.92	117.4	267.3	279.4	696,435	312,264
Oct 1983	—	—	270.0	281.0	693,225	311,418
Nov 1983	—	—	271.4	281.6	688,459	317,485
Dec 1983	53.70	119.6	273.2	283.7	690,750	333,595
Jan 1984	—	—	274.7	283.3	689,807	326,619
Feb 1984	—	—	278.4	286.5	702,553	335,906
Mar 1984	55.30	123.1	281.9	288.0	—	—
Apr 1984	—	—	286.1	290.2	—	—
May 1984	—	—	288.3	—	—	—

UNITED STATES

	Producer Price Index[1]		Consumer Price Index[2]	GNP Implicit Price Deflator[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
	Industrial Commodities (1967=100)	All Commodities (1967=100)	(1967=100)	(1972=100)	Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1983 Avg.	315.8	303.1	298.4	215.63	12.67	13.44	10.58	8.66
Jun 1983	315.3	302.4	298.1	214.55	12.66	13.38	10.52	8.63
Jul 1983	316.5	303.2	299.3	—	12.68	13.56	10.58	8.69
Aug 1983	317.3	304.7	300.3	—	12.63	13.46	10.61	8.64
Sep 1983	317.1	305.3	301.8	216.44	12.71	13.47	10.69	8.75
Oct 1983	318.5	306.0	302.6	—	12.78	13.56	10.78	8.73
Nov 1983	318.3	305.5	303.1	—	12.72	13.56	10.86	8.78
Dec 1983	318.4	306.1	303.5	218.53	12.85	13.34	10.89	8.86
Jan 1984	319.1R	308.0R	305.2	—	12.67R	13.38R	10.91R	8.88R
Feb 1984	320.4	308.8	306.6	—	12.81R	13.34R	10.90R	8.86R
Mar 1984	321.9	311.1	307.3	220.60R	12.85R	13.33R	10.95R	8.88R
Apr 1984	322.5	311.4	308.8	—	12.98P	13.29P	10.97R	8.89R
May 1984	323.3	311.7	309.7	—	—	—	11.02P	8.89P

P = Preliminary R = Revised since last month

For annual averages prior to 1983, and for notes pertaining to these statistics, see pages 23-26 of Report 190 of June 1984.

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AUGUST 1984 **NUMBER 192**

MONTHLY REPORT

ON THE NUCLEAR FUEL MARKET

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MONTHLY REPORT ON THE NUCLEAR FUEL MARKET

August 1984 No. 192

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PRICING

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To Our Readers

Nuexco will host a hospitality suite during the Uranium Institute's Ninth Annual Symposium in London, England. The suite will be located at the Savoy Hotel, September 5 7. We look forward to seeing you there.

* * *

We are pleased to announce that **Mr. Clark M. Beyer** has joined Nuexco to assist Wes Miller with the production of the Monthly Report. Clark is a recent graduate of Stanford University.

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NATURAL URANIUM AND CONVERSION

The **Exchange Value** as of July 31, 1984 is **$17.50** per pound U_3O_8, unchanged since last month. The *Current Market Data* section of this Report lists six uranium sales transactions, involving a total of approximately 1.3 million pounds U_3O_8 *equivalent*. Three of those transactions were sales of enriched UF_6, two involved concentrates, and one involved natural UF_6.

Active supply of uranium (U_3O_8 and UF_6) for spot and near-term delivery totals **2.9 million** pounds U_3O_8 or equivalent UF_6, down 1.4 million pounds since last month. The corresponding figure for **active demand** is **940 thousand** pounds, down 960 thousand pounds. The spot and near-term **supply-demand ratio** rose to **3.1:1.**

The **Transaction Value** as of July 31, 1984 is **$16.60** per pound U_3O_8, up $0.10 since last month. The current Transaction Value includes 10 transactions involving a total of 3.9 million pounds U_3O_8 or equivalent UF_6 and covers a period of 4 months.

The **Loan Use Charge Rate** as of July 31, 1984 is **6 percent** per annum, unchanged since last month. No uranium loans are reported.

* * *

The Exchange Value is unchanged at $17.50, primarily because of the continued presence in the market of sellers prepared to offer material at or near that level in order to conclude transactions for near-term delivery and payment. Of the active sellers, several are non-US, and are motivated by the current strength of the US dollar compared to other currencies. Reflecting a seasonal phenomenon, the pace of market activity has slowed recently, and fewer bids and offers are being transmitted.

The drop in near-term uranium supply during recent months can be attributed to the reluctance of most US producers to offer at current market prices, as well as to the completion of a substantial volume of inventory selling. This month's drop in demand is due partly to one large buyer's having begun final negotiations toward a contract. Any upward price movement must await the activation of buyers having actual requirements, as opposed to discretionary buyers motivated only by bargain prices.

* * *

The **Conversion Value** remains **$0.00** per pound U in UF_6, due primarily to the continued absence of active demand for conversion services. In addition, some holders of U_3O_8 can swap for natural UF_6, at no cost, with natural uranium sellers wishing to deconvert their material. Active supply of conversion services for delivery within three years amounts to 2.8 million pounds U in UF_6. No secondary market conversion transactions are reported.

SECONDARY MARKET ENRICHMENT SERVICES

The secondary market **SWU Values** as of July 31, 1984 are **$95** for **DOE origin** and FY85 delivery, unchanged, and **$85** for **non-DOE origin** and delivery within approximately 15 months, an increase of $5. The *Current Market Data* section of this Report lists thirteen secondary market SWU sales, involving approximately 3.2 million SWUs. Four of those transactions were assignments of DOE origin SWUs. Active near-term SWU supply amounts to 510 thousand SWUs, while active demand amounts to 335 thousand SWUs.

The DOE origin SWU Value is unchanged at $95 because the remaining active sellers continue to offer substantial discounts to interested buyers. Most buyers seek relatively small quantities of SWUs to fill requirements for the coming fiscal year, but many are hesitating to act until they make final long-term enrichment contracting decisions. The non-DOE SWU Value is up $5, possibly reflecting the beginning of a shift in market dominance from secondary market sellers to non-DOE primary suppliers.

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CURRENT MARKET DATA

July 31, 1984	Market Values	Active Supply[1] (thousands)	Active Demand[1] (thousands)
EXCHANGE VALUE	**$17.50**/lb. U_3O_8	2,900	940
CONVERSION VALUE	**$0.00**/lb. U in UF_6	2,825	0
SWU VALUES			
DOE origin, FY85 delivery	**$95**/SWU	510	335
non-DOE origin, delivery within 15 months	**$85**/SWU		
LOAN USE CHARGE RATE	**6%**/annum	7,050	0

TRANSACTION VALUE	**$/lb. U_3O_8**	**Millions of Pounds**	**Number of Transactions**	**Number of Months**
	16.60	3.9	10	4

[1] Supply and demand tables in the *Current Market Data* section of this Report detail the numbers for each category. Quantities of SWUs (Separative Work Units) are not referenced to a particular origin.

DEFINITIONS

1. The **Exchange Value** is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.
2. The **Conversion Value** is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.
3. The **SWU Values** represent Nuexco's judgment of the price at which transactions for the sale of significant quantities of SWUs of stated origin for delivery in the specified time period could be concluded as of the date indicated.
4. The **Loan Use Charge Rate** is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.
5. The **Transaction Value** is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:
   a. Transactions closed within the previous three-month period for which delivery is scheduled within one year of the transaction date;
   b. At least ten transactions;
   c. Transactions involving a sum total of at least 2 million pounds U_3O_8 equivalent.

   The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars using conversion rates in effect on or near the transaction date.

DERIVATIONS AND COMMENTS

1. All Market Values are based on:
   a. Data from recently completed transactions.
   b. Data from pending transactions.
   c. Firm bids to buy or borrow, and firm offers to sell or lend.
   d. Prices purchasers or rates borrowers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy or borrow, and prices sellers or rates lenders have expressed a willingness to offer, but for which Nuexco is not aware of firm offers to sell or lend.
2. Prices associated with deliveries under old or renegotiated contracts or other than arm's-length transactions are not considered in the determination of these Market Values.
3. In the determination of the Conversion Value, Nuexco does not consider transportation charges other than those customarily provided by primary suppliers of conversion services.
4. The prices of conversion services or SWUs delivered under long-term contracts with primary suppliers are not considered in the determination of either the Conversion Value or SWU Value.
5. For the SWU Values, Nuexco converts SWU prices at varying tails and product assays to equivalent SWU prices at the DOE Reference Transaction Tails Assay (presently 0.20 weight-percent U_{235}) and a product assay of 3.0 weight-percent U_{235}, assuming feed costs corresponding to Nuexco's Exchange and Conversion Values determined as of the same date.
6. In calculating the Transaction Value, Nuexco does not account for the price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of future Exchange Values or any other indeterminant variable. Also excluded from the calculation are any other transactions in which the delivery price is defined in such a way that it cannot currently be determined.

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EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
Country (currency)	This Month (July 31, 1984)	Last Month (June 30, 1984)	12 Months Ago (July 31, 1983)	This Month (July 31, 1984)	Last Month (June 30, 1984)	12 Months Ago (July 31, 1983)
Australia (dollar)	21.08	20.21	27.27	54.81	52.55	70.89
Belgium (comm. franc)	1,023	992.06	1,263	2,661	2,579	3,284
Canada (dollar)	23.01	23.03	29.57	59.82	59.87	76.89
Finland (markka)	106.58	103.24	134.83	277.08	268.41	350.53
France (franc)	155.42	149.57	189.72	404.05	388.86	493.24
FRG (mark)	50.64	48.71	63.19	131.64	126.62	164.28
Italy (lira)	31,117	30,027	37,383	80,896	78,065	97,188
Japan (yen)	4,304	4,152	5,780	11,189	10,794	15,028
Netherlands (guilder)	57.23	54.88	70.44	148.78	142.67	183.14
South Africa (rand)	28.62	23.68	26.37	74.40	61.56	68.57
Spain (peseta)	2,861	2,766	3,582	7,439	7,191	9,313
Sweden (krona)	146.81	143.09	185.04	381.68	372.00	481.07
Switzerland (franc)	43.08	40.75	50.92	112.00	105.93	132.39
UK (pound)	13.37	12.94	15.72	34.77	33.65	40.86
US (dollar)	17.50	17.50	24.00	45.50	45.50	62.39

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
Country (currency)	This Month (July 31, 1984)	Last Month (June 30, 1984)	12 Months Ago (July 31, 1983)	This Month (July 31, 1984)	Last Month (June 30, 1984)	12 Months Ago (July 31, 1983)
Australia (dollar)	20.00	19.06	26.70	52.00	49.55	69.42
Belgium (comm. franc)	970.76	935.37	1,237	2,524	2,432	3,216
Canada (dollar)	21.82	21.71	28.96	56.74	56.45	75.29
Finland (markka)	101.10	97.35	132.02	262.83	253.08	343.23
France (franc)	147.42	141.03	185.77	383.27	366.64	482.96
FRG (mark)	48.03	45.92	61.87	124.87	119.39	160.86
Italy (lira)	29,516	28,312	36,604	76,736	73,604	95,163
Japan (yen)	4,083	3,915	5,660	10,614	10,177	14,715
Netherlands (guilder)	54.28	51.74	68.98	141.13	134.51	179.32
South Africa (rand)	27.15	22.33	25.82	70.57	58.05	67.14
Spain (peseta)	2,714	2,608	3,507	7,056	6,780	9,119
Sweden (krona)	139.26	134.91	181.19	362.05	350.75	471.05
Switzerland (franc)	40.87	38.42	49.86	106.24	99.88	129.63
UK (pound)	12.69	12.20	15.39	32.98	31.73	40.01
US (dollar)	16.60	16.50	23.50	43.16	42.90	61.09

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[1] Calculated using currency exchange rates published in the *Wall Street Journal* on July 31, 1984.

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CURRENT MARKET DATA

CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U as UF$_6$ This Month (July 31, 1984)	per lb. U as UF$_6$ Last Month (June 30, 1984)	per lb. U as UF$_6$ 12 Months Ago (July 31, 1983)	per kg. U as UF$_6$ This Month (July 31, 1984)	per kg. U as UF$_6$ Last Month (June 30, 1984)	per kg. U as UF$_6$ 12 Months Ago (July 31, 1983)
Australia (dollar)	0.00	0.00	1.25	0.00	0.00	2.76
Belgium (comm. franc)	0.00	0.00	57.89	0.00	0.00	127.64
Canada (dollar)	0.00	0.00	1.36	0.00	0.00	2.99
Finland (markka)	0.00	0.00	6.18	0.00	0.00	13.62
France (franc)	0.00	0.00	8.70	0.00	0.00	19.17
FRG (mark)	0.00	0.00	2.90	0.00	0.00	6.39
Italy (lira)	0.00	0.00	1,713	0.00	0.00	3,777
Japan (yen)	0.00	0.00	264.93	0.00	0.00	584.08
Netherlands (guilder)	0.00	0.00	3.23	0.00	0.00	7.12
South Africa (rand)	0.00	0.00	1.21	0.00	0.00	2.66
Spain (peseta)	0.00	0.00	164.18	0.00	0.00	361.95
Sweden (krona)	0.00	0.00	8.48	0.00	0.00	18.70
Switzerland (franc)	0.00	0.00	2.33	0.00	0.00	5.15
UK (pound)	0.00	0.00	0.72	0.00	0.00	1.59
US (dollar)	0.00	0.00	1.10	0.00	0.00	2.43

SWU VALUES EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU FY85 (July 31, 1984)	DOE SWU FY85 (June 30, 1984)	Non-DOE SWU delivery within 15 months (July 31, 1984)	Non-DOE SWU delivery within 15 months (June 30, 1984)
Australia (dollar)	114.46	109.74	102.41	92.41
Belgium (comm. franc)	5,556	5,385	4,971	4,535
Canada (dollar)	124.90	125.02	111.75	105.28
Finland (markka)	578.56	560.47	517.66	471.98
France (franc)	843.69	811.97	754.88	683.76
FRG (mark)	274.88	264.40	245.95	222.66
Italy (lira)	168,919	163,006	151,138	137,268
Japan (yen)	23,364	22,539	20,905	18,980
Netherlands (guilder)	310.66	297.90	277.96	250.86
South Africa (rand)	155.36	128.55	139.00	108.25
Spain (peseta)	15,533	15,015	13,898	12,644
Sweden (krona)	796.98	776.78	713.09	654.13
Switzerland (franc)	233.87	221.19	209.26	186.26
UK (pound)	72.60	70.27	64.96	59.17
US (dollar)	95.00	95.00	85.00	80.00

[1] Calculated using currency exchange rates published in the *Wall Street Journal* on July 31, 1984.

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CURRENT MARKET DATA

RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
3069	1984	101-300	unknown	European Producer	European Broker	
3067A	1984	101-300	indeterminate	European Entity	US Fabricator	Enriched UF_6.
3059A	1984	less than 50	indeterminate	US Fabricator	European Utility	High-enriched UF_6.
3057	1985	50-100	102	US Fabricator	US Utility	Natural UF_6.
3003	1984	301-600	95-105	Canadian Producer	US Utility	
2972C	1985	301-600	96	European Entity	European Utility	Enriched UF_6. Assumes $80 per SWU and 0.20 tails assay. Buyer exercised option.

Continued on next page.

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CURRENT MARKET DATA

RECENT TRANSACTIONS[1] *(continued)*

Secondary Market Enrichment Services

Nuexco Transaction Number	Delivery Period[2]	Approximate Quantity[3] (thousands of SWUs)	Approximate Price[4] as Percent of Current SWU Value[5]	Seller Group	Buyer Group	SWU Origin	Remarks
3072	1987-90	101-300	unknown	European Entity	European Entity	Eurodif	
3071	1985-86	601-1,000	unknown	European Entity	US Utility	DOE	
3070	1984	less than 50	104	European Entity	US Fabricator	Eurodif	
3068	1987-90	101-300	see remarks	European Entity	US Utility	Eurodif	Fixed annual prices.
3067B	1984	50-100	104	European Entity	US Fabricator	Eurodif	Enriched UF_6.
3062	1985	50-100	105	European Utility	US Utility	DOE	
3061	1985	less than 50	109-111	US Utility	US Utility	DOE	
3059B	1984	less than 50	indeterminate	US Fabricator	European Utility	unknown	High-enriched UF_6.
3058	1985	101-300	94	European Utility	US Utility	DOE	
3050	1987-91	101-300	see remarks	European Entity	Non-US Utility	Eurodif	Fixed prices, subject to ceiling.
3048	1987	101-300	114	European Entity	US Utility	Eurodif	
3045	1987-90	601-1,000	unknown	European Entity	European Entity	Eurodif	
2972D	1985	less than 50	93	European Entity	European Utility	Eurodif	Enriched UF_6. Buyer exercised option.

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[1] Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.

[2] Refers to calendar year, not fiscal year.

[3] For sales of enriched UF_6, if tails assay was not designated, Nuexco's calculation of SWU quantity assumes 0.20 w/o tails assay.

[4] Price is not normalized to 0.20% tails assay.

[5] Refers to SWU Value for same origin as SWUs included in transaction.

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CURRENT MARKET DATA

URANIUM SUPPLY
(As of 7/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale: ACTIVE			
1575	—	500 per year	
1818	—	500 per year	1985-90
2201	95	—	
2236	—	200 per year	1985-89
2263	—	500 per year	1985-90
2275	145	—	
2288*	45	—	UF_6
2315*	—	1,000	1987-90
2336	—	250 per year	
2368	—	2,800	
2392	35	—	UF_6
2429*	450	—	
2484	130	—	
2489	—	500	1986-90
2509	1,200	1,600	UF_6
2521	50	100	U_3O_8 or UF_6
2556	350	—	UF_6
2565	400	—	
TOTAL:	2,900		
INACTIVE			
0564	—	1,000 per year	1985-90
2191	125	—	UF_6
2193	—	800 per year	1986-90
2271	—	500 per year	1984-88
2297*	—	200 per year	1985-89
2326	—	3,500	1988-91
2389*	300	—	
2473	—	500 per year	1984-90
2495	130	—	UF_6
2514	—	1,000 per year	
2553	300	—	
TOTAL:	855		

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*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

Projects removed since last month: 2134, 2390, 2436A, 2505.

CURRENT MARKET DATA

URANIUM DEMAND
(As of 7/31/84)

	Delivery Period[1] (Thousands of Pounds U_3O_8)		
Nuexco Project Number	**Spot or Near-term[2]**	**Intermediate or Long term**	**Remarks**
Inquiries to Purchase: **ACTIVE**			
2217	—	1,000 per year	1988-95
2329	—	500	1985
2352	240	—	
2456	650	—	UF_6
2506	50	—	U_3O_8 or UF_6
2528*	—	250 per year	1991 on
TOTAL:	940		
INACTIVE			
1999	—	50 per year	1985-90
2244	—	350 per year	
2414	—	150 per year	1987-91
2442	—	250 per year	1986 on
2457	—	650	1987
2507	—	300	1987-88
2542A	1,400	—	enriched UF_6
2555*	—	200 per year	1986-89
TOTAL:	1,400		

*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

Projects removed since last month: 2355A, 2372, 2413, 2419, 2494, 2558, 2566.

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LOAN SUPPLY
(As of 7/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8)		Remarks
	Within 1 Year	Beyond 1 Year	
Available for Loan: ACTIVE			
1938	2,000	—	UF_6
2128	2,500	—	
2139	2,000	—	
2483	550	—	
TOTAL:	7,050		

Projects removed since last month: 2453.

CONVERSION SUPPLY AND DEMAND
(As of 7/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF_6)		Remarks
	Within 3 Years	Beyond 3 Years	
Available for Sale: ACTIVE			
2141	2,600	—	
2511	225	—	
TOTAL:	2,825		
INACTIVE			
2051	1,000	—	
2401	600	—	
2438*	500	250	1985-87
2511*	600	700	1986-90
TOTAL:	2,700		
Inquiries to Purchase: INACTIVE			
2420	300	—	1986
TOTAL:	300		

*New or revised since last month.

[1] Measured from the date of this Report.

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CURRENT MARKET DATA

SWU SUPPLY
(As of 7/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
2100	—	100 per year	1986-87
2164*	80	—	
2285*	—	1,000	
2351*	—	150	1986-88
2408*	50	60	1986
2428*	100	50	
2510*	200	—	
2513*	25	25	1986
2550*	55	—	
TOTAL:	510		
INACTIVE			
2192*	10	—	
2345	150	—	
TOTAL:	160		

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*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

Projects removed since last month: 2436B, 2469.

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SWU DEMAND
(As of 7/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	 Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2407*	35	35	1986
2430*	100	—	
2443*	75	—	
2452	30	—	1985
2480*	50	—	
2503	—	330	1986
2519	—	30 per year	1987 on
2522	20	—	
2543*	10	20	1986
2562*	15	30	1986
TOTAL:	335		
INACTIVE			
2346*	—	300	1987-89
2449	50	—	
2454	75	75	1986
2459	50	50 per year	
2471	60	40 per year	
2479	—	50	1986
2512	—	15 per year	1987 on
2542B	340	—	enriched UF_6
2552	35	—	
TOTAL:	610		

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*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

Projects removed since last month: 2237, 2355B, 2432A, 2432B, 2518, 2544, 2546, 2550, 2567.

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ESSAY

THE CHANGING ROLE OF BROKERS

Introduction

During the past four to six years, many nuclear fuel market participants have faced particularly difficult inventory and supply problems. In many cases, brokers have helped solve these problems by facilitating the redistribution of goods and services through such means as secondary market sales, other transactions between unfamiliar parties, or deals that an individual fuel manager might be precluded from executing.

During the mid to late 1970s, when prices generally were on an upward trend, as little as 10 percent of the goods and services that changed hands involved brokers. By contrast, Nuexco's review of nuclear fuel market transactions closed in 1983 indicated that transactions involving brokers accounted for approximately 30 percent by monetary value, and 20–50 percent by volume, of the total goods and services exchanged (excluding primary market sales of conversion and enrichment services) (Table 1). Those percentages do not in any way imply trends or permanent relationships, but rather are useful to indicate the extent of brokers' current involvement in nuclear fuel transactions. Corresponding figures for the year ended June 30, 1984 indicate a brokers' participation of approximately 35 percent, both by volume and by monetary value.

Table 1

BROKER PARTICIPATION IN 1983 NUCLEAR FUEL MARKET TRANSACTIONS

Material/Service	Percent of Total Volume Brokered
natural uranium concentrates	20
natural UF_6	40
secondary market conversion services	50
secondary market enrichment services	50

Brokers' Services

Brokerage services have become particularly useful during the past few years as the number of near-term uranium sales and secondary market sales of conversion and enrichment has increased, and the market has become truly international. In the broadest sense, the broker's business is to improve the market's efficiency by expediting the movement of resources from where they are less needed to where they are more needed. To do so, the broker brings buyers and sellers together and helps parties find solutions to problems encountered during negotiations.

The broker's basic services are to identify opportunities to clients, to assist clients in structuring and transmitting bids, offers, and inquiries, and to perform other customary services necessary for the conclusion of transactions. Bids and counter-bids are submitted on behalf of buyers, while offers and counter-offers are submitted on behalf of sellers. The procedures and terminology associated with these conventional market tools are reviewed in Report 188 (April 1984), in the essay entitled *Bids, Offers and Inquiries*.

Through a comprehensive communications network, a broker may have contact with virtually all competitive market participants on both the buy and sell sides of the market. Those contacts can be highly advantageous in that they provide a perspective on competitive bids or offers that is often unavailable to the individual buyer or seller. The broker's contacts make available to the client a wider range of market opportunities than the client alone may be aware of. For example, a broker may know of unique opportunities, such as companies wanting to buy or sell on a one-time basis. Through its position as a knowledgeable intermediary, the broker may be able to structure complex transactions involving several parties, deals that an individual market participant may be precluded from executing.

One particularly valuable service that a broker may render is the protection of a client's identity. To do this, the broker can submit to other market participants anonymous bids, offers or inquiries on behalf of the client. The client may have various reasons for wishing to remain anonymous. For example, in order to meet a scheduled delivery obligation, a producer may choose to purchase uranium rather than produce it—a decision having important competitive implications. By using a broker, a buyer or seller also can make a bid or offer incorporating new prices, terms, conditions, or ideas, without a commitment to reveal its identity unless the bid or offer is accepted. Or, the buyer or seller might use an anonymous inquiry to ascertain whether such new terms would be acceptable.

A related technique is the simultaneous inquiry, a proposal designed for simultaneous evaluation by a selected

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buyer and seller. Typically, a broker would submit such a proposal to a buyer and a seller that, based on the broker's prior knowledge of their interests and individual situations, appeared to be a suitable match. The principal advantage of the simultaneous inquiry is that the broker initiates the contact. Thus, neither the buyer nor the seller needs to reveal its identity or expose its negotiating posture, and either can legitimately disclaim authorship of the proposal.

A company choosing to liquidate materials and obligations associated with U_3O_8, conversion services, UF_6, enrichment services, enriched uranium, or fabricated fuel might be accustomed primarily to purchasing activities. If so, it can obtain valuable assistance from a broker in the formulation and execution of effective sales strategies. Because a company's inventory carrying charges alone may amount to several million dollars per year, the economic advantages of more efficient fuel arrangements can be enormous.

Compensation

As the complexity of the nuclear fuel market has increased over the past few years, brokerage organizations have become more versatile. In the past, it was generally possible to distinguish among three types of full-time or part-time brokers:

1. Those employed by individual buyers or sellers as consultants or agents;
2. Those that performed a non-partisan role, seeking to match various opportunities on both sides of the market and to structure transactions;
3. Those that bought and sold uranium and related services for their own accounts (traders or dealers).

In recent years the distinctions among these types of brokerage organizations have become blurred. The primary brokers in the nuclear fuel market may now engage, to some extent, in any or all three of those types of brokerage activities. As a result, the means by which an individual broker earns compensation may vary widely with the particulars of a transaction or client relationship.

If the broker has an exclusive client relationship such as that of a consultant, compensation is likely to be based on a fixed rate or charge paid regardless of the quantity traded or the dollar value of the transaction. If the exclusive relationship involves marketing by the broker, compensation may take the form of a fixed percentage of the price obtained.

In the majority of transactions in the current market, brokers do not have exclusive relationships with clients, but rather have bi-partisan relationships with both the buyer and the seller. Normally broker fees are a specified and agreed-upon amount per pound U_3O_8, per KgU, or per SWU (thus removing the broker from any interest in the price level of the business). Sellers generally pay fees, unless there is a strong seller's market (more buyers than sellers, more demand than supply, and upward pressure on prices), such as that which existed from the mid to late 1970s. The determination of which party pays the broker's fee in a balanced market was once thought to be the subject of considerable negotiation, but in recent years the fee has come to be accepted as a selling expense.

As an alternate means of obtaining compensation, the broker may take a middle position in a transaction, buying from one party and selling to another, earning a fee on the spread between purchase price and sale price. Such a transaction is customarily called a back-to-back transaction, because the broker takes title to the commodity only momentarily, in a brief intermediate step that involves no risk. A back-to-back transaction may be nothing more than a device for the principal parties in the transaction to pay a brokerage fee without issuing explicit payment instructions. In that case, neither buyer nor seller needs to record (or report) a payment for brokerage services.

If a broker retains title to material prior to arranging its resale, thereby assuming a risk, the broker may be considered a dealer, but the implications of such a role are not always clear. A broker may take title to material for the limited purpose of facilitating a complex transaction between other parties, rather than to become a true dealer, trading for his own risk and account. However, compensation for a dealer always comes from the difference between the buying price and the selling price. The amount of compensation can be large or small, even negative, depending on the results the dealer achieves.

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RECENT DEVELOPMENTS

AUSTRALIA

At its biennial federal convention July 9–13, the ruling Australian Labor Party (ALP) essentially affirmed the uranium policy it established tentatively in November 1983. The policy allows Ranger and Nabarlek to continue U_3O_8 production and export, but prohibits mining of any undeveloped uranium properties except for the Olympic Dam copper-uranium deposit. It also forbids exports of Australian uranium to France as long as the French military performs nuclear weapons tests in the South Pacific. As an added note, the final policy prohibits nuclear power plants or any fuel cycle facilities from being built in Australia.

There had been indications during the months preceding the ALP convention that the Party would liberalize the uranium policy. Senior ministers in the government stated that the policy lessens Australia's ability to influence international nuclear issues, and harms relations with important European trading partners. The Australian Science and Technology Council (ASTEC) completed a report on May 31 supporting the ministers' point of view, advocating a more active role for the nation in the nuclear fuel cycle. At the ALP convention, the reasoning of the senior ministers and scientists encountered the customary emotional opposition.

In 1983, Australia produced a total of 8.4 million pounds U_3O_8, ranking it seventh among the seven uranium-producing nations of the free world that produced more than 3 million pounds. While expansion of the Ranger project and the mining of Olympic Dam could add substantially to annual capacity in the future, the restrictive commercial conditions imposed by the government have by now relegated Australia to a position of secondary importance in the uranium market.

SOUTH AFRICA

Second quarter production from Chamber of Mines producers amounted to 3.79 million pounds U_3O_8, down slightly from the level of 3.85 million pounds produced in the first quarter of the year (Table 2). Significant declines occurred at JMS (down 25.6 percent), Harmony (down 15.7 percent), and Chemwes (down 10.0 percent), but were largely offset by production increases at Randfontein (up 25.9 percent) and Vaal Reefs (up 5.6 percent). The changes in output from individual facilities represent normal variations in tons treated, so the expected 1984 output from Chamber of Mines producers remains unchanged at approximately 15.5 million pounds U_3O_8.

Table 2

**REPUBLIC OF SOUTH AFRICA:
SECOND QUARTER 1984
URANIUM PRODUCTION[1]
(Thousands of pounds U_3O_8)**

Operation	First Quarter 1984	Second Quarter 1984	Year to Date
Beisa (St. Helena)[2]	338	333	671
Blyvooruitzicht	155	132	287
Buffelsfontein	313	331	644
Chemwes (Stilfontein)	310	279	589
Dreifontein Consolidated	98	104	202
ERGO[3]	113	94	207
Harmony	307	259	566
Hartebeestfontein	248	253	501
JMS[4]	356	265	621
Randfontein	287	361	648
Vaal Reefs	1,069	1,129	2,198
Western Areas	175	171	346
Western Deep Levels	79	82	161
TOTAL	3,848	3,793	7,641

[1] Excludes Palabora Mining Company, which is not a member of the Chamber of Mines.

[2] Uranium production scheduled to end by November 31, 1984.

[3] ERGO = East Rand Gold and Uranium Co. Ltd.

[4] JMS = Free State Joint Metallurgical Scheme.

AMPLIFICATION

Commercial Fuel Cycle Facilities in Japan

Last month's Report (Number 191, page 21) discussed a proposal by the Federation of Electric Power Companies (FEPC) to build commercial-scale enrichment, reprocessing, and waste storage facilities at a site in northern Honshu. The first sentence of the article incorrectly implies that the waste storage facility will hold spent fuel (high-level waste). In actuality, the storage facility will be designed to hold up to 3 million drums (600,000 m³) of low-level waste. The reprocessing plant, scheduled to have a capacity of 800 metric tons per year, will have an initial capacity to store 3,000 tons of spent fuel. The FEPC has established a budget of approximately 1 trillion yen (more than $4 billion) for the three-facility project.

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THE PALABORA PROJECT

Introduction

The Palabora project in the Republic of South Africa is one of the highest volume open-pit mines in the world, with over 100 million metric tons (tonnes) of ore and waste removed annually. Copper is the principal product recovered, along with four by-product minerals including uranium. In 1983 Palabora produced 218.6 tonnes U_3O_8 (482,000 pounds) from 29 million tonnes of ore sent to the mill. Uranium production in South Africa currently is limited to the Palabora mine and to the Witwatersrand gold district.

Palabora Mining Company Ltd. (Palabora) operates the project, which is located in the Letaba district, Northeastern Transvaal Lowveld (Figure 1). Formed in 1956, Palabora originally was a joint venture including Rio Tinto Zinc Ltd. of London (now RTZ) and Newmont Mining Corporation of New York; the two companies' interests currently amount to 38.9 and 28.6 percent, respectively. Palabora dedicated the early years of the project to evaluation of the main ore deposit as a source of copper. Actual mining began in 1964; by the end of 1983, 1.2 billion tonnes of ore and waste had been mined.

History of Discovery

The Palabora ore deposit is implaced in a carbonatite and foskorite host rock that forms the core of the much larger Palabora Igneous Complex (Figure 2). The carbonatite core proved more resistant to erosion than surrounding rocks, thus forming a prominent hill, Loolekop, that became a landmark to early travelers through the region. Copper mineralization was reported on Loolekop around 1870 by the first European settlers. They described strong showings of copper mineralization throughout the highland area, plus evidence of primitive excavations where ancient people mined the ore and recovered the copper in small clay smelting pots. Archaeologists estimate that the early mining began some 1200 years ago and continued until the late 1800s.

In 1912, Dr. Hans Merensky initiated the first detailed geologic assessment of the Palabora Igneous Complex. He noted the presence of large reserves of vermiculite and phosphate (apatite) minerals in addition to copper. A small company, South African Phosphate Ltd., started mining phosphates in 1932 in a valley below Loolekoop, but the operation failed financially after extraction of some 4500 tonnes. In 1939 Merensky formed the Transvaal Ore Company for the purpose of exploiting the known vermiculite occurrence. The Phosphate Development Corporation (Foskor) began large-volume mining of phosphates in the early 1950s; Palabora began mining copper in the following decade. Presently, three open-pit mines are operating within the complex: Palabora's main copper mine, Palabora's vermiculite mine, and Foskor's phosphate mine (Figure 2).

Exploration Activity

Members of the geological unit of the South African Atomic Energy Board established the presence of uranothorianite in association with the copper mineralization in 1952. The Mineral Development Section of the Atomic Energy Board evaluated the economic potential of uranium during the period 1953–1956. After considerable surface drilling and underground exploration drifting, the uranium content of the deposit was demonstrated to be well below economic levels for recovery, and attention shifted back to the potential value of copper.

Palabora gained control of a key portion of the carbonatite core zone at the time the joint venture was formed in 1956, and detailed evaluation of the copper potential began late that year. The exploration team drilled 111 inclined holes from the surface at an average length of 370 meters, a total of 41,000 meters. Over 7,000 meters of horizontal drilling was completed in association with underground exploration drifting. The underground work enabled geologists to determine the continuity of the mineralization and to collect a bulk sample of ore for metallurgical testing. Three inclined core holes encountered almost continuous copper mineralization to a vertical depth of 1,000 meters.

Drilling results indicated the presence of an estimated 286 million tonnes of copper ore averaging 0.68 percent. Several other minerals occur within the copper-bearing zone, including extremely low-grade uranium.

Geology

Geologists believe that the Palabora Igneous Complex intruded sequentially into Archean granite during the Precambrian period. Overall, the complex influenced an area about 8 kilometers in a north-south direction and 3 kilometers east-west. There are 14 different rock types associated with the complex, of which the youngest intrusion is the transgressive carbonatite core that constitutes a major part of the Palabora ore deposit. The carbonatite core has been age-dated at approximately 2060 million years. It is estimated that the sequence of intrusions was

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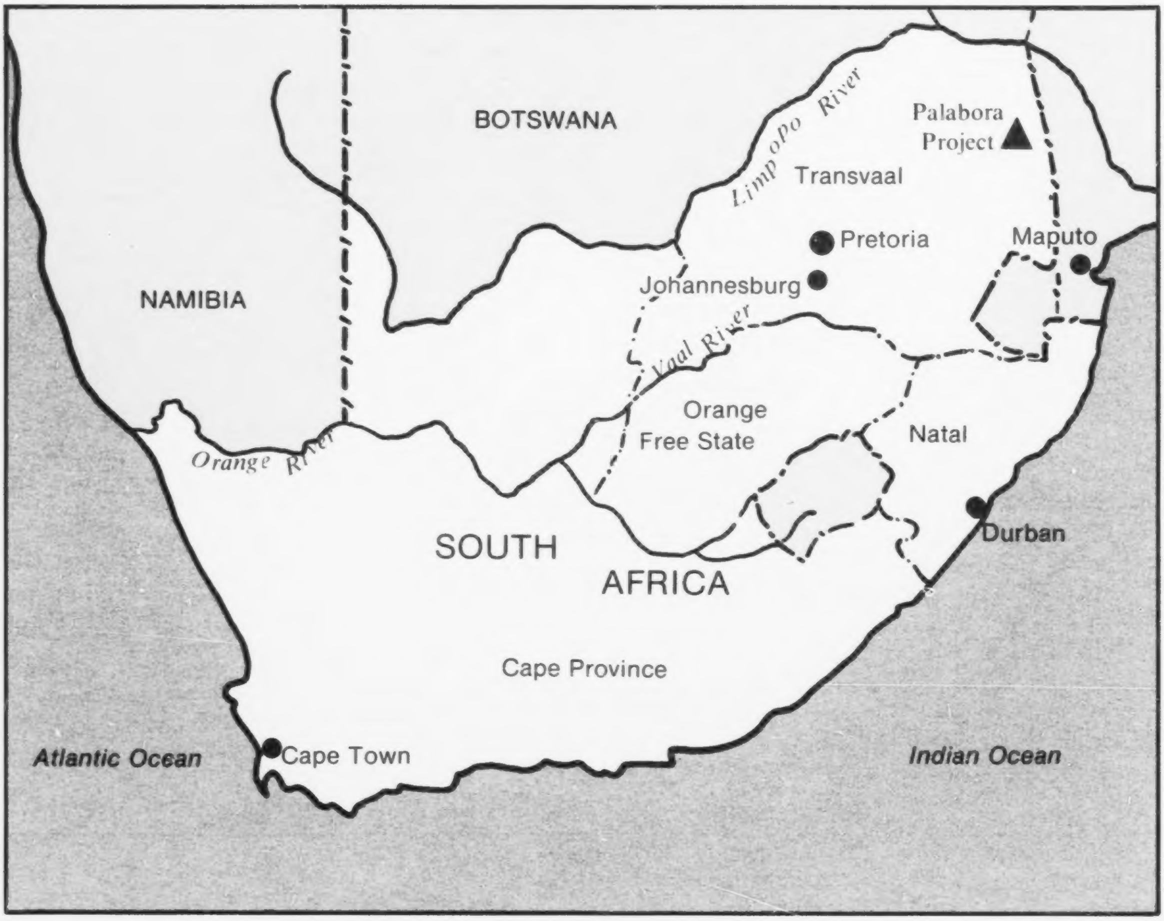
Figure 1

LOCATION OF PALABORA PROJECT, REPUBLIC OF SOUTH AFRICA


BOTSWANA
Limpopo River
Palabora Project
Transvaal
Pretoria
Maputo
Johannesburg
NAMIBIA
Vaal River
Orange Free State
Natal
Orange River
Durban
SOUTH AFRICA
Cape Province
Atlantic Ocean
Cape Town
Indian Ocean

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somewhat continuous, so the earlier intrusions are considered only slightly older than the core.

The intrusions contain a series of rock-forming minerals high in magnesium, iron, sodium, phosphate and carbonate. The transgressive carbonatite core intruded into a banded carbonatite segment; the younger rock is distinguished by lighter color, finer grain, lack of foliation and banding, and high content of copper sulfides and accessory minerals. Both the transgressive and the banded carbonatite intrusions consist primarily of calcite and dolomite. The carbonatite intrusions are surrounded in turn by a vertical volcanic pipe of foskorite, a rock composed of olivine/serpentine, magnetite, apatite and phlogopite.

It is clear from the position of the transgressive carbonatite core that the younger rock sequences of the Palabora Igneous Complex intruded in mass or as radiating dike swarms along lines of weakness developed during each preceding intrusion. The position of the transgressive core is controlled by two pre-existing fracture systems at the center of the banded carbonatite. The system containing the main mass trends about N 85 degrees E; the other system is about N 65 degrees W, and includes a series of carbonatite dikes extending three to four hundred meters along the trend. The placement of the Palabora ore deposit was definitely controlled by the two strong fracture patterns.

Mineralization

The mineralization in the main ore deposit is believed to be of epigenetic origin. Following the intrusion of the transgressive carbonatite, the core cooled and intense fracturing ensued. The fracturing provided access subsequently for migrating fluids, and led to deposition of minerals in rich veinlets. Generally the veins are less than two centimeters wide and are continuous for up to one meter both horizontally and vertically.

The banded carbonatite and foskorite contain widely scattered grains of copper sulfide mineralization (mostly bornite). Since it occurs as discreet grains disseminated throughout the rock, it is considered syngenetic. The copper mineral content decreases from the core into the older rocks. However, essentially all banded carbonite and a substantial portion of foskorite are mined and processed as copper ore.

The principal ore minerals at Palabora are chalcopyrite and bornite, both copper sulfides. Three other copper sulfide minerals are present in minor amounts and contribute to the total copper recovered. In addition, twelve other sulfides of copper, nickel and iron are present in minor to trace amounts. Gold, silver, platinum and palladium also occur in trace amounts. Those minerals are recovered from the final sludge generated in the electrolytic refining process, while nickel sulfate is recovered from the tankhouse electrolyte.

The source of uranium at Palabora is the mineral uranothorianite $(U\ Th)O_2$, which contains approximately 45 percent U and 43 percent Th. Uranothorianite occurs in small amounts in close association with copper sulfide mineralization.

Project Development

Following several years of property evaluation, Palabora determined that recovery of copper by large-volume open-pit mining would be economical, and that recovery of at least four by-product minerals would improve project economics substantially. The company launched the project on that basis in July 1963. Prior to mine development, Palabora acquired part of the Foskor property in order to accommodate long-range mine schedules for expansion of the pit. At the same time, the company assumed full control of the vermiculite mining operation from Transvaal Ore Company. The main development eventually would require an open pit approximately 2000 meters wide having a depth of 805 meters below the crest of Loolekop. Figure 3 is an idealized vertical cross-section through the pit.

Mine development and construction of processing facilities began in 1964. The initial plant design capacity involved crushing 30,000 tonnes of ore per day to produce 73,000 tonnes of anode and blister copper annually. In the first full year of production, 1966, over 10.9 million tonnes or ore were milled. Annual tonnages mined and milled have increased steadily since then. In 1969, Palabora increased the milling rate to 52,000 tonnes ore daily, and in 1976, further expansion increased the milling capacity to 80,000 tonnes ore per day, thereby increasing anode copper production to approximately 125,000 tonnes annually. The daily mining rate for ore and waste since 1980 has averaged almost 330,000 tonnes, including one 24-hour period when a record 521,000 tonnes were loaded and hauled from the pit.

Original projections of the project's life extended through 1992. In August 1979, following extensive engineering studies, Palabora announced plans to enlarge the open pit in all dimensions to further the life of the project by five years, to 1997. Approximately 625,000 tonnes of copper will be produced during the extended period, and the recovery of by-product minerals will continue at about the same rate.

The company built a pilot plant on site in 1967 to con-

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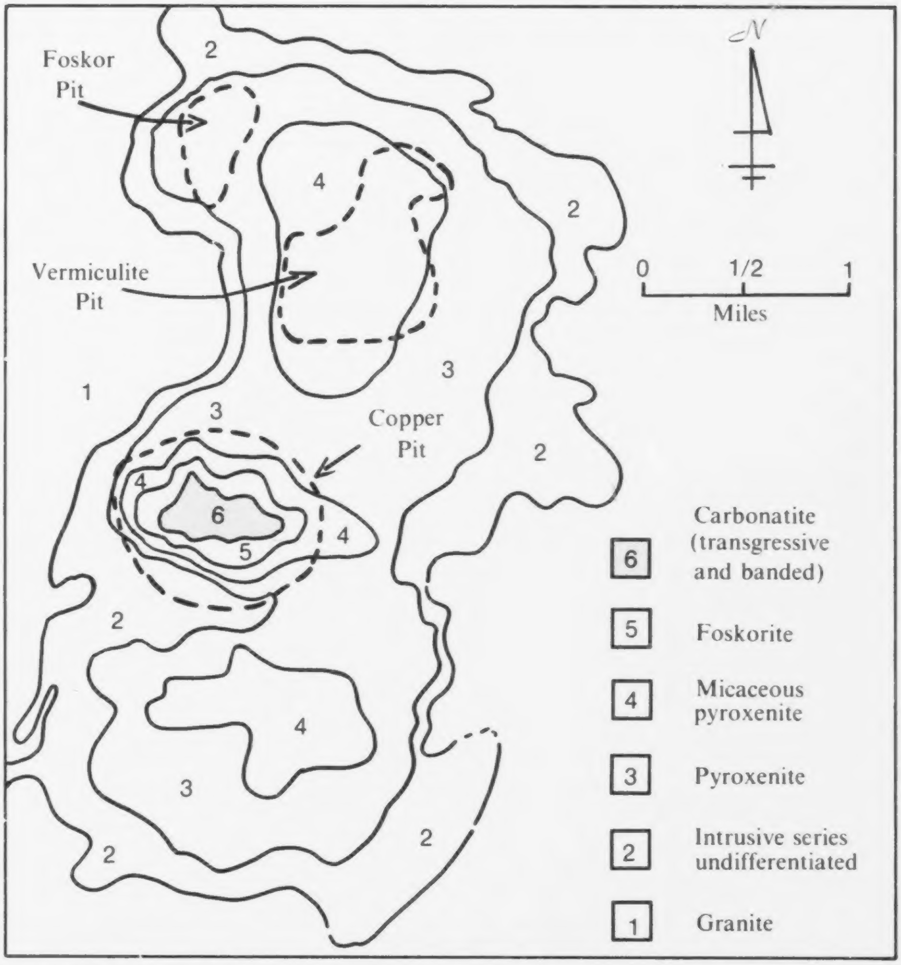
Foskor Pit
2
N
4
2
Vermiculite Pit
0
1/2
1
Miles
3
1
3
Copper Pit
2
4
6
4
5
2
4
3
2
2
6 Carbonatite (transgressive and banded)
5 Foskorite
4 Micaceous pyroxenite
3 Pyroxenite
2 Intrusive series undifferentiated
1 Granite

Figure 2. Generalized geologic map of Palabora Igneous Complex, showing location of three operating mines. (Map adapted from Van Der Spuy, 1982.)

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centrate the heavy-mineral fraction of the ore. The plant provided the bulk concentrate samples required to finalize chemical extraction procedures for all heavy minerals. Once procedures were finalized, the company built a gravity concentration plant large enough to process the tailings from the copper plant (about 25,000 tonnes per day), primarily to recover uranium and zirconium.

Commercial-scale recovery of uranium began in 1971. In that year, Palabora recovered approximately 61 tonnes of uranium concentrates (135,000 pounds) from 19 million tonnes of ore. Uranium recovery increased annually to over 500,000 pounds in 1981 and has remained near that level through the first half of 1984. Production may increase to more than 600,000 pounds U_3O_8 annually as a result of the current expansion program. Figure 4 shows a recent aerial view of the Palabora open pit and ore processing facilities.

Ore Processing

Ore from the pit goes through three-stage crushing to reduce grain size to minus ¾-inch. Water is added as the ore moves to the rod and ball mill grinding circuit for reduction to a fine powder. Pumps send the fine-ground slurry through a cyclone; the overflow goes to the flotation circuit and the underflow gravitates back to the grinding circuit for recycling.

Approximately 80,000 tonnes fine-ground ore per day enters eight banks of continuous flotation cells. Chemical reagents are mixed with the slurry from the grinding circuit to be aerated and mechanically agitated. The copper minerals become attached to air bubbles and float to the surface to be skimmed off, forming a copper concentrate of 36 percent. The heavy mineral fraction is in the residue and leaves the flotation circuit as tailings. About 62,000 tonnes per day move on to magnetic separators where magnetite is recovered as the first by-product.

The non-magnetic tailings, some 35,000 tonnes per day, are moved to the heavy minerals plant for uranium and zirconium recovery. A gravity separation process employing Reichert cones separates both minerals from the tailings stream. Following separation in the Reichert cones, the heavy-mineral concentrate moves on to shaker tables, where further concentration and separation of the uranium and zirconium occurs. The high-phosphate portion of the tailings stream is pumped to the Foskor plant for recovery of phosphate values.

The uranium content of the feed to the Reichert cones averages about 0.0035 percent U_3O_8, while the concentration of the feed entering the shaker tables is approximately 0.2 percent U_3O_8. It exits the shaker tables in concentrations up to 5.0 percent U_3O_8 and 14.0 percent ThO_2. Approximately 25 tonnes of uranothorianite concentrate are produced daily.

Uranothorianite concentrate is added to an agitated leach vat containing a 60-percent nitric acid solution preheated to 75 degrees Celsius. An exothermic reaction increases the temperature to 100 degrees during the leach time of 45 minutes per batch. The leach pulp is filtered, and the uranium-charged liquor is transferred to the continuous solvent extraction circuit.

The uranium liquor contains traces of thorium, copper and lead as it enters the six-stage counter-current mixer unit. An organic solvent consisting of 10 percent tributyl phosphate is added. After a 25-minute contact time, the loaded organic is scrubbed with a 12-percent bleed-off of OK liquor to remove all traces of foreign material. The scrubbed organic is then stripped in an eight-stage circuit using a nitric acid solution heated to 40 degrees Celsius. The product is OK liquor containing 30 to 50 grams U_3O_8 per liter.

Precipitation of uranium concentrates occurs in two stages. In the first stage, the pH of the OK liquor is increased from 1.0 to 3.7 by bubbling ammonia gas through it for almost seven hours. The second stage includes the addition of more ammonia, raising the pH to 7.5 to complete precipitation of ammonium diuranate (ADU). The ADU slurry is thickened and filtered on a rotary-drum vacuum filter. The filter cake is repulped and sent to a calcining furnace, where it is prepared for packaging. The final product accounts for approximately 50 percent of the uranium contained in the heavy-mineral fraction of the tailings stream that enters the gravity concentration circuit.

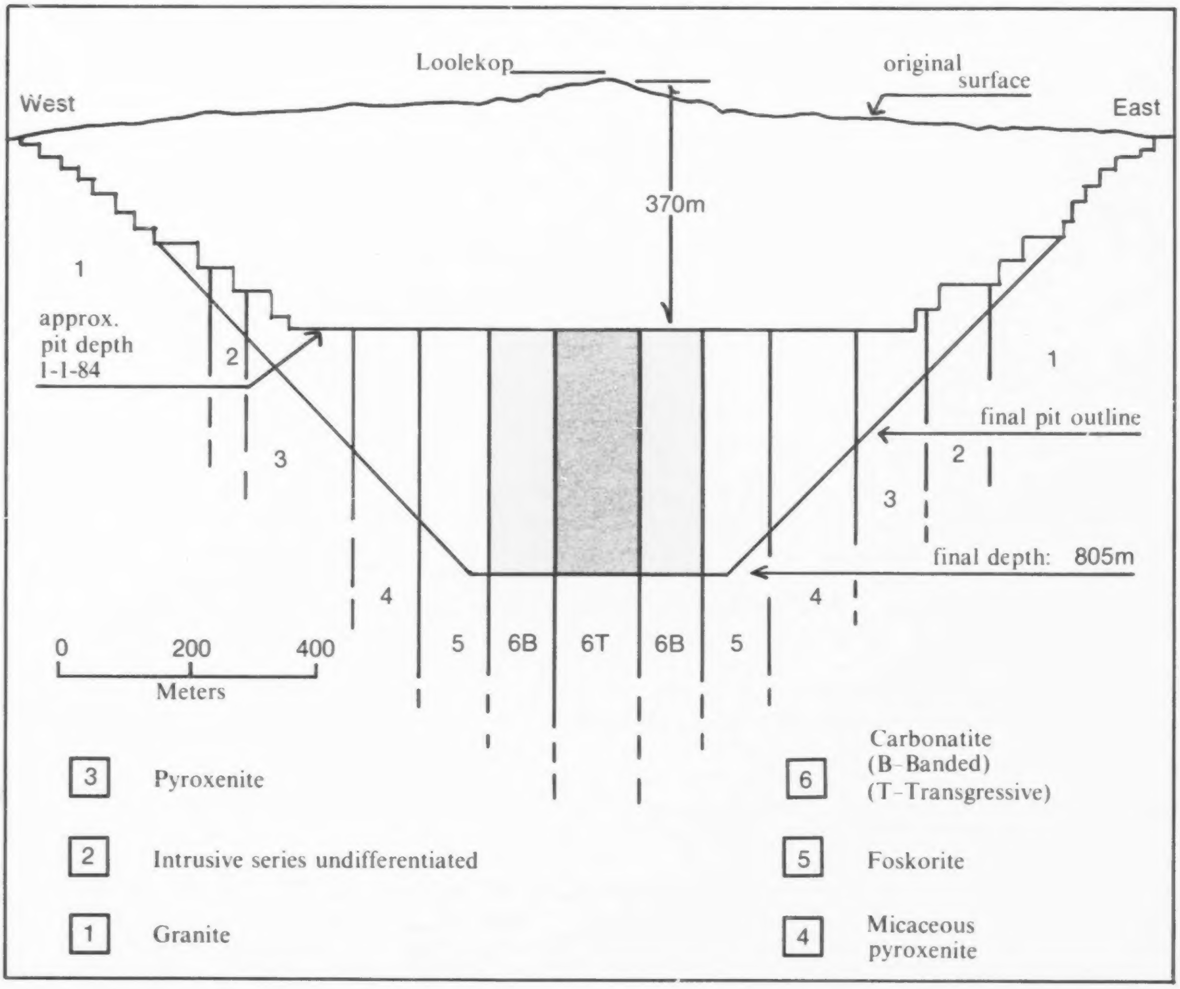
Loolekop
original surface
West
East
370m
1
approx. pit depth 1-1-84
2
3
4
5
6B
6T
6B
5
4
3
2
1
final pit outline
final depth: 805m
0
200
400
Meters
3 Pyroxenite
2 Intrusive series undifferentiated
1 Granite
6 Carbonatite (B-Banded) (T-Transgressive)
5 Foskorite
4 Micaceous pyroxenite

Figure 3. Idealized East-West vertical section through the Palabora open pit, illustrating mine plan in relation to intrusive rock sequence.

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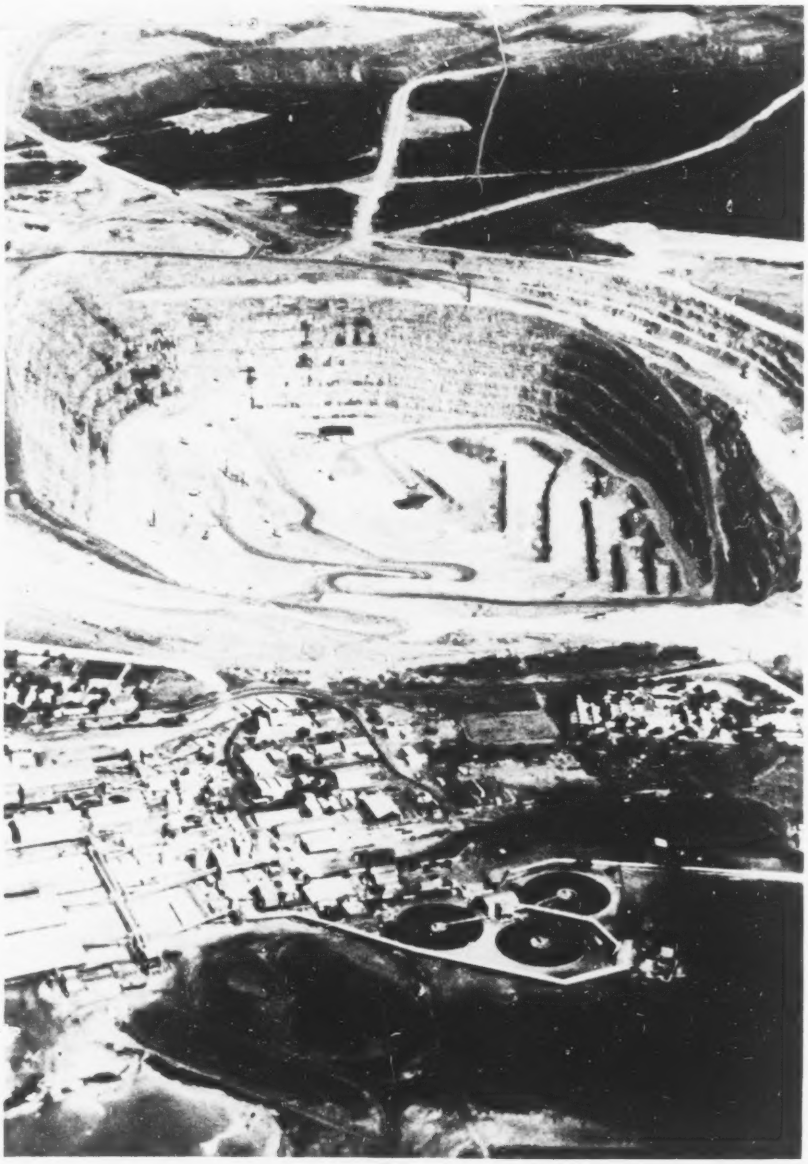

Figure 4. Aerial view of open pit and processing plant.

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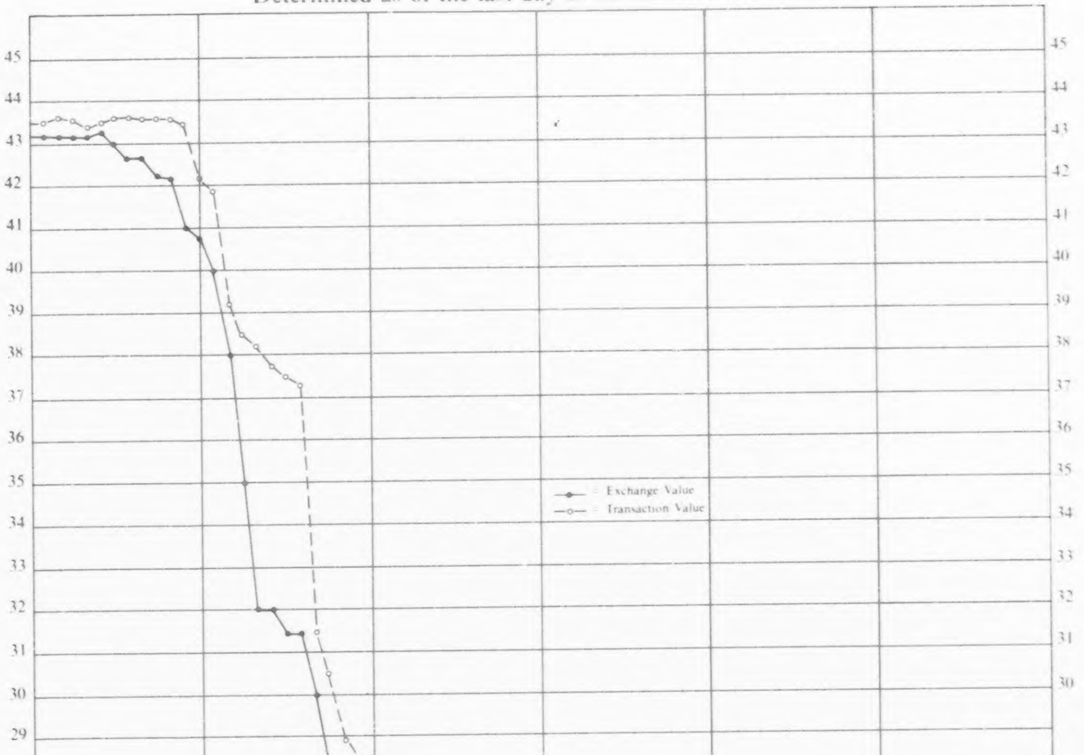
HISTORICAL MARKET DATA

EXCHANGE AND TRANSACTION VALUES SINCE JANUARY 1979

Determined as of the last day of the month indicated



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HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	32.50	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00
1984	20.50	17.50	17.00	17.75	17.75	17.50	**17.50**					

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85
1984	23.05	22.50	19.25	17.90	17.00	16.50	**16.60**					

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60
1984	0.60	0.30	0.80	0.80	0.80	0.00	**0.00**					

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GOVERNMENT STATISTICS

AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage Earners, Weekly Rates[2] (1976=100)
1983 Avg.	401.2	182.4R
Apr 1983	407.3	180.9R
May 1983	414.7	180.9R
Jun 1983	415.6	181.0R
Jul 1983	408.3R	180.7R
Aug 1983	403.0R	180.7R
Sep 1983	402.9R	180.6R
Oct 1983	397.5R	188.3R
Nov 1983	395.5R	188.3R
Dec 1983	399.2R	188.1R
Jan 1984	399.1R	188.3R
Feb 1984	402.3R	188.2R
Mar 1984	403.8R	188.0R
Apr 1984	404.0	195.6R

R = Revised since last month

CANADA

		Wage-earner Data: Average Hourly Earnings (C$)[2]					
	Industry Selling Price Index: Manufacturing[1] (1971=100)	Uranium Mines (SIC 057)	Metal Mines (SIC 051-059)	Mines, Quarries and Oil Wells[3] (SIC 051-099)	Primary Metal Industries Non-ferrous[4] (SIC 296)	(SIC 298)	Chemicals and Chemical Products[5] (SIC 372-379)
1983 Avg.	298.8	—	14.69	14.30	—	—	11.17
Jul 1983	300.4	16.48	14.35	13.93	11.70	9.83	11.04
Aug 1983	301.3	16.93	14.36	13.89	11.82	10.08	11.19
Sep 1983	301.1	17.66	14.90	14.41	11.99	10.32	11.29
Oct 1983	301.6	17.73	15.27	14.65	11.76	10.03	11.30
Nov 1983	301.8	17.82	15.29	14.67	11.78	10.62	11.38
Dec 1983	302.9	17.84	15.11	14.66	11.86	10.60	11.51
Jan 1984	305.4R	17.74	15.27	14.74	11.91	10.84	11.69
Feb 1984	306.6R	17.78	15.59	14.90	12.04	10.82	11.51
Mar 1984	308.9R	18.05	15.52	14.82	12.14	10.84	11.58
Apr 1984	310.4R	18.06	15.83	15.10	11.96	10.34	11.63
May 1984	310.5R	—	15.50P	15.04P	12.10P	10.15P	11.59P
Jun 1984	310.9P	—	—	—	—	—	—

P = Preliminary R = Revised since last month

For annual averages prior to 1983, and for notes pertaining to these statistics, see pages 23-26 of Report 190 of June 1984.

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GOVERNMENT STATISTICS

REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per per Metric Ton of Gold Ore Milled (Rand)[1]	Tonnage-Weighted Index of Average Working Costs per Metric Ton of Gold Ore Milled (March 1982=100)[2]	Consumer Price Index[3] (1975=100)[4]	Producer Price Index All Groups[5] (1975=100)	Total Employment in Mining and Quarrying (Code 35)[6]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[6]
1983 Avg.	51.87	115.0	262.2	274.8	696,579	3,644,772
Jul 1983	—	—	262.5	273.7	704,202	314,566
Aug 1983	—	—	265.6	278.9	698,984	311,789
Sep 1983	52.92	117.4	267.3	279.4	696,435	312,264
Oct 1983	—	—	270.0	281.0	693,225	311,418
Nov 1983	—	—	271.4	281.6	688,459	317,485
Dec 1983	53.70	119.6	273.2	283.7	690,750	333,595
Jan 1984	—	—	274.7	283.3	689,807	326,619
Feb 1984	—	—	278.4	286.5	702,553	335,906
Mar 1984	55.30	123.1	281.9	288.0	715,628	342,332
Apr 1984	—	—	286.1	290.2	—	—
May 1984	—	—	288.3	292.6	—	—
Jun 1984	—	—	291.2	—	—	—

UNITED STATES

	Producer Price Index[1]		Consumer Price Index[2]	GNP Implicit Price Deflator[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
	Industrial Commodities (1967=100)	All Commodities (1967=100)	(1967=100)	(1972=100)	Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1983 Avg.	315.8	303.1	298.4	215.63	12.57R	13.43R	10.59R	8.65R
Jun 1983	315.3	302.4	298.1	214.55	12.55R	13.37R	10.52	8.63
Jul 1983	316.5	303.2	299.3	—	12.59R	13.56	10.59R	8.67R
Aug 1983	317.3	304.7	300.3	—	12.54R	13.46	10.62R	8.62R
Sep 1983	317.1	305.3	301.8	216.44	12.62R	13.46R	10.70R	8.73R
Oct 1983	318.5	306.0	302.6	—	12.67R	13.55R	10.79R	8.71R
Nov 1983	318.3	305.5	303.1	—	12.64R	13.56	10.86	8.77R
Dec 1983	318.4	306.1	303.5	218.53	12.75R	13.33R	10.90R	8.84R
Jan 1984	319.1	308.0	305.2	—	12.67	13.38	10.91	8.88
Feb 1984	320.6R	308.9R	306.6	—	12.81	13.34	10.90	8.86
Mar 1984	321.9	311.1	307.3	220.58R	12.85	13.33	10.95	8.88
Apr 1984	322.5	311.4	308.8	—	12.91R	13.30R	10.97	8.89
May 1984	323.3	311.7	309.7	—	12.91P	13.36	10.99R	8.87R
Jun 1984	323.9	311.4	310.7	222.31P	—	—	11.03P	8.89

P = Preliminary R = Revised since last month

For annual averages prior to 1983, and for notes pertaining to these statistics, see pages 23-26 of Report 190 of June 1984.

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NUEXCO

EXECUTIVE SUMMARY
REPORT 192
(All data as of July 31, 1984)

Exchange Value $17.50, unchanged	The **Exchange Value** is **$17.50** per pound U_3O_8, unchanged since last month. Six recent uranium sales are reported, involving a total of 1.3 million pounds U_3O_8 equivalent. Three were sales of enriched UF_6.
Supply-Demand Ratio rose to 3.1:1	Active spot and near-term **uranium supply** amounts to **2.9 million** pounds U_3O_8 equivalent, down 1.4 million pounds since last month. Active spot and near-term **uranium demand** totals **940 thousand** pounds, down 960 thousand pounds. The spot and near-term **supply-demand ratio** rose to **3.1:1.**
Transaction Value rose $0.10, to $16.60	The **Transaction Value** is **$16.60** per pound U_3O_8, up $0.10 since last month. The calculation includes 10 transactions involving a total of 3.9 million pounds U_3O_8 and equivalent UF_6, and covers a period of 4 months.
Loan Use Charge Rate unchanged at 6%	The **Loan Use Charge Rate** remains **6 percent** per annum.
Conversion Value remained at $0.00	The **Conversion Value** is **$0.00** per pound U as UF_6, unchanged since last month. No secondary market conversion transactions, and no active conversion demand, are reported. Active secondary market supply of conversion services for delivery within three years totals 2.8 million pounds U as UF_6.
SWU Values $95 for DOE-origin (FY85) $85 for non-DOE origin (delivery within 15 months)	The **SWU Values** are **$95** per SWU of DOE origin and FY85 delivery, unchanged, and **$85** per SWU of non-DOE origin, up $5 since last month. Thirteen SWU transactions are reported, involving 3.2 million SWUs. Active secondary market SWU supply amounts to 510 thousand SWUs, while active demand totals 335 thousand SWUs.
Essay	Brokers have been involved in a large percentage of nuclear fuel market transactions in recent years, and their organizations have become increasingly versatile.
Australia	The ruling Labor Party reaffirmed the uranium policy established last November, which permits uranium production at Ranger, Nabarlek, and Olympic Dam, but otherwise preserves the restrictive commercial environment.
South Africa	Second-quarter uranium production from Chamber of Mines producers amounted to 3.8 million pounds U_3O_8, down slightly from the first quarter.
Raw Materials	The Palabora project in South Africa is one of the largest open-pit mining projects in the world. It produces close to 500,000 pounds U_3O_8 annually as a by-product of copper production.

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NUEXCO REPORT 192 FIGURES OF THE MONTH (July 31, 1984)	This Month (Report 192)	Last Month (Report 191)	12 Months Ago (Report 180)
Exchange Value[1]	17.50	17.50	24.00
Transaction Value[1]	16.60	16.50	23.50
Conversion Value[2]	0.00	0.00	1.10
Loan Use Charge Rate[3]	6%	6%	6%
Near-Term Uranium Supply[4]	2.9	4.3	7.1
Near-Term Uranium Demand[5]	0.9	1.9	2.6
Near-Term Supply-Demand Ratio	3.1	2.2	2.8
Recent Uranium Sales:			
Number of Transactions[6]	6	4	5
Quantity of Material[7]	1.3	5.8	0.8-1.5
Nuexco SWU Values:[8]			
DOE origin, FY85 delivery	95	95	—
non-DOE origin, delivery within 15 months	85	80	—
USDOE SWU Prices:			
USEC	135.00	135.00	—
AFC	153.00[9]	153.00[9]	138.65
Requirements	157.00[9]	157.00[9]	149.85
Market Value of Enriched UF_6[10] [11]:			
2.5 w/o U_{235}	512.54	512.54	598.47
3.0 w/o U_{235}	659.57	659.57	764.27
3.5 w/o U_{235}	809.59	809.59	932.90
4.0 w/o U_{235}	961.65	961.65	1,103.64

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[1] US $ per pound U_3O_8 equivalent.

[2] US $ per pound U as UF_6.

[3] Per annum.

[4] Active inquiries to sell, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[5] Active inquiries to purchase, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[6] Uranium sales only; does not include loans, conversion, or SWU transactions.

[7] Millions of pounds U_3O_8, equivalent.

[8] US $ per SWU.

[9] Effective 10/1/84.

[10] Calculated using the Nuexco Exchange Value, Conversion Value, and 0.20 percent tails assay. From 2/28/83 through 9/30/83, calculations used the Nuexco SWU Value for the relevant fiscal year. From 10/31/83 through 2/29/84, calculations used the Nuexco SWU Value for DOE origin and FY84 delivery. As of 3/31/84, calculations use the Nuexco SWU Value for DOE origin and FY85 delivery.

[11] US $ per KgU as UF_6.

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SEPTEMBER 1984 **NUMBER 193**

MONTHLY REPORT

ON THE NUCLEAR FUEL MARKET

NUEXCO

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MONTHLY REPORT ON THE NUCLEAR FUEL MARKET

September 1984 No. 193

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PRICING

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To Our Readers

Nuexco is pleased to announce that Mr. **James J. Lightner** is moving to our European office this month, where he will be an Associate. Jim has been the Associate Editor of the Monthly Report for the past nine months.

We are also pleased to announce that Ms. **Kathleen Rouhota** has joined Nuexco's Atlanta office as an Associate. Kathleen is a recent honors graduate of Georgia Institute of Technology, having earned a B.S. in Industrial Management. Kathleen is a native of Greece, and speaks Greek, French, and English fluently.

James J. Lightner

* * *

Nuexco will host a hospitality suite during the Atomic Industrial Forum's Uranium Seminar in Keystone, Colorado, September 30 to October 3. We look forward to seeing you there.

* * *

As of September 1, 1984, Nuexco's Menlo Park office will no longer be using TWX number 910-373-1760. We can still be reached via telex number 470674, answerback NUEXCO UI.

Kathleen Rouhota

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NATURAL URANIUM AND SECONDARY MARKET CONVERSION

The **Exchange Value** as of August 31, 1984 is **$17.50** per pound U_3O_8, unchanged since last month. The *Current Market Data* section of this Report lists four uranium sales transactions, involving a total of approximately 1.0 million pounds U_3O_8 *equivalent*. One of those sales involved natural UF_6.

Active supply of natural uranium (U_3O_8 and UF_6) for spot or near-term delivery totals **5.1 million** pounds U_3O_8 or equivalent UF_6, up 2.2 million pounds since last month. The corresponding figure for **active demand** is **1.1 million** pounds, up approximately 200 thousand pounds. The spot and near-term **supply-demand ratio** rose to **4.6:1.**

The **Transaction Value** as of August 31, 1984 is **$16.40** per pound U_3O_8, down $0.20 since last month. The current Transaction Value includes 10 transactions involving a total of 3.9 million pounds U_3O_8 or equivalent UF_6 and covers a period of 4 months. While all four of the transactions reported this month involved deliveries before 1986, only one of them met the criteria for inclusion in the current Transaction Value calculation.

The **Loan Use Charge Rate** as of August 31, 1984 is **6 percent** per annum, unchanged since last month, in a nearly dormant market.

* * *

The Exchange Value is unchanged at $17.50; material is still available for sale at or below that level, particularly in small lots. The virtual absence of active buyers for significant quantities in recent weeks forestalled the development of any impetus for upward price movement. Downward price pressure was largely attributable to lots of less than 100,000 pounds U_3O_8. Under other circumstances, such small lots might have been significant, but as of the end of August significant quantities amounted to 200,000-300,000 pounds. The actions of one or two potential buyers of large quantities of material (upwards of one million pounds U_3O_8) could cause substantial price movements in the next several months, especially if sellers offer insufficient quantities at current prices. Substantial supplies are, of course, available at higher prices, but whether such prices will materialize largely depends on how the buyer(s) approach the market. Rapid, aggressive procurement efforts probably would lead to price firming, while a more measured approach could well leave market prices relatively unchanged. Finally, given time to exploit the leverage created by a large purchase, the buyer(s) might be able to negotiate aggressively enough to force the price down further.

The sharp increase in uranium supply this month is attributable primarily to the addition of a few large producers offering substantial quantities of material for near-term delivery. Several other potential sellers, including producers and users having large unneeded inventories, are awaiting the appearance of firm demand, at which time they will compete to conclude sales.

* * *

The **Conversion Value** is **$0.80** per pound U as UF_6, up from $0.00, due to the August reemergence of a substantial quantity of active conversion demand. Furthermore, unlike last month, sellers of natural UF_6 are presently able to compete with U_3O_8 sellers without the need to discount to zero the value of the conversion component associated with their material.

Active supply of secondary market conversion services for delivery within three years amounts to 2.8 million pounds U in UF_6. Active secondary market conversion demand for delivery within these years totals 845 thousand pounds U as UF_6. No secondary market conversion transactions are reported.

SECONDARY MARKET ENRICHMENT SERVICES

The **SWU Values** as of August 31, 1984 are **$100** for **DOE origin** and FY85 delivery, up $5, and **$85** for **non-DOE origin** and delivery within approximately 15 months, unchanged. The *Current Market Data* section of this Report lists six secondary market SWU sales, involving approximately 700,000 SWUs. Two of those transactions involved SWUs of Eurodif origin. Active near-term SWU supply on the secondary market amounts to 215,000 SWUs, while active demand amounts to 325,000 SWUs.

The DOE origin SWU Value rose this month as the available supply of secondary market SWUs for FY85 delivery fell below the current demand, and some of the remaining active sellers increased their offering prices. Most of the currently active buyers seek relatively small quantities of SWUs to fill requirements for the coming fiscal year, but many are hesitating to act until they make final long-term enrichment contracting decisions. The deadline given to DOE customers for their decision to convert to the Utility Services enrichment contract (USEC) is October 1, 1984, so many market participants will be making those decisions during September. Demand on the secondary market could increase substan-

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tially thereafter. The non-DOE origin SWU Value remained unchanged at $85 per SWU, so the differential relative to the DOE value increased to $15 per SWU. That differential represents the additional incentive demanded by buyers that are free to buy SWUs of any origin.

Activity is increasing in the secondary market for FY86 SWUs, as indicated by the fact that three of the six SWU transactions reported this month involved FY86 SWUs. Prices vary widely, as do payment terms; generally, FY86 SWUs are being priced at $18–20 discounts relative to the USEC price.

* * *

Since January of 1984, in its continuing effort to preserve its customer base in the primary enrichment market, DOE has been offering price concessions to customers that convert or express their intent to convert their existing DOE contracts to the USEC. Requirements customers that have notified DOE of their intent to convert to the USEC have been able to take FY84 deliveries at $135.00 per SWU, rather than the $149.85 per SWU that currently applies to DOE SWUs under Requirements contracts. (As of October 1, the Requirements *contract price* will rise from $149.85 to the lower of the new *published price* of $157.00 per SWU, or the new *ceiling charge*, which probably will fall slightly below the published price.) Fixed-commitment contract prices will rise to $153.00 per SWU on October 1, so the DOE price concession to those customers converting to the USEC will rise from the present level of $3.65 per SWU to $18.00 per SWU.

Nuexco is aware of eleven utilities that, as of August 31, had actually signed the USEC: Carolina Power & Light Co., Commonwealth Edison Company, Dairyland Power Cooperative, Detroit Edison Co., Duke Power Co., Houston Lighting and Power Company, Philadelphia Electric Co., Public Service Electric and Gas Co., Tennessee Valley Authority, Washington Public Power Supply System, and Chubu Electric Power Company (Japan). Table 1 shows an update of DOE customers' status on conversion to the USEC. Arranged by MWe of generating capacity within buyer regions, it indicates that DOE will be successful in retaining almost all of its US and Japanese customers, while losing much of its market share in Europe.

It appears, as expected, that DOE will succeed in converting to the USEC contracts covering at least 84 percent of US nuclear generating capacity now covered by DOE contracts, and possibly as much as 100 percent. Although DOE cannot expect to supply 100 percent of requirements for all the reactors covered by conversion to the USEC, of the US utilities that have signed the contract, only Commonwealth Edison has signed for less than the full 100 percent of enrichment needs. Thus, the actual DOE share of the US enrichment market probably will exceed 70 percent.

Nuexco expects that, in addition to Chubu Electric Power Company, all of DOE's Japanese customers eventually will convert, and they generally are very interested in the possibility of purchasing less than 100 percent from DOE. However, their final decisions have become more dependent upon the prospect of incremental SWU pricing ($60 to $85 per SWU) currently under review at DOE and reported in several technical publications. Such proposals would apply only to the 30 percent of utilities' requirements that need not be covered by the USEC.

Present indications are that customers representing at least 50 percent (14.6 MWe) of the European generating capacity now supplied by DOE (29.2 MWe) will refuse to convert to the USEC. Customers representing one-sixth of the total will convert, and the remaining one-third of the total is as yet uncertain. Approximately one-half (7.2 MWe) of the capacity in the *Indicated Will Not Sign* category is covered by Requirements contracts, so it is likely DOE will lose virtually that entire amount.

Given the competition among DOE, Eurodif (represented by Cogema), and Urenco, many utilities have delayed making any decision regarding the USEC until they have reviewed the most recent offering prices. For now, DOE has not made any firm offers of incrementally-priced SWUs, but their tactic has indeed forestalled consideration of non-DOE offers at some utilities, especially in the USA and Japan.

Correction

Last month's Report listed a secondary market sale of enrichment services incorrectly. For Nuexco reference number 2972D (page 6, Report #192), the quantity should have been shown as "101-300," rather than "less than 50."

Table 1

REGIONAL STATUS OF CONVERSION TO USEC
(Expressed in GWe of Generating Capacity)

Current Status	Former Status		
	Requirements Contracts		Fixed-Commitment Contracts
	3.5-year	5-year	
USA			
Signed	16.1	13.4	15.2
Indicated Intent to Sign[1]	8.3	16.2	26.0
No Indication	7.3	3.5	7.1
Indicated Will Not Sign	0.5	—	—
Europe			
Signed	—	—	—
Indicated Intent to Sign[1]	0.6	0.6	3.7
No Indication	1.0	—	8.7
Indicated Will Not Sign	6.2	1.0	7.4
Japan			
Signed	0.5	—	1.9
Indicated Intent to Sign[1]	3.1	5.6	13.0
No Indication	—	—	—
Indicated Will Not Sign	—	—	—
Other			
Signed	—	—	—
Indicated Intent to Sign[1]	—	—	8.5
No Indication	—	—	0.6
Indicated Will Not Sign	—	—	—

[1] Category is not limited to "letters of intent" that DOE has received, but also includes general expressions of interest.

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CURRENT MARKET DATA

August 31, 1984	Market Values	Active Supply[1] (thousands)	Active Demand[1] (thousands)
EXCHANGE VALUE	**$17.50**/lb. U_3O_8	5,055	1,050
CONVERSION VALUE	**$0.80**/lb. U in UF_6	2,825	845
SWU VALUES			
DOE origin, FY85 delivery	**$100**/SWU	215	325
non-DOE origin, delivery within 15 months	**$85**/SWU		
LOAN USE CHARGE RATE	6%/annum	0	0

	$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
TRANSACTION VALUE	**16.40**	3.9	10	4

[1] Supply and demand tables in the *Current Market Data* section of this Report detail the numbers for each category. Quantities of SWUs (Separative Work Units) are not referenced to a particular origin.

DEFINITIONS

1. The **Exchange Value** is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.
2. The **Conversion Value** is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.
3. The **SWU Values** represent Nuexco's judgment of the price at which transactions for the sale of significant quantities of SWUs of stated origin for delivery in the specified time period could be concluded as of the date indicated.
4. The **Loan Use Charge Rate** is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.
5. The **Transaction Value** is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:
   a. Transactions closed within the previous three-month period for which delivery is scheduled within one year of the transaction date;
   b. At least ten transactions;
   c. Transactions involving a sum total of at least 2 million pounds U_3O_8 equivalent.

   The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars using conversion rates in effect on or near the transaction date.

DERIVATIONS AND COMMENTS

1. All Market Values are based on:
   a. Data from recently completed transactions.
   b. Data from pending transactions.
   c. Firm bids to buy or borrow, and firm offers to sell or lend.
   d. Prices purchasers or rates borrowers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy or borrow, and prices sellers or rates lenders have expressed a willingness to offer, but for which Nuexco is not aware of firm offers to sell or lend.
2. Prices associated with deliveries under old or renegotiated contracts or other than arm's-length transactions are not considered in the determination of these Market Values.
3. In the determination of the Conversion Value, Nuexco does not consider transportation charges other than those customarily provided by primary suppliers of conversion services.
4. The prices of conversion services or SWUs delivered under long-term contracts with primary suppliers are not considered in the determination of either the Conversion Value or SWU Value.
5. For the SWU Values, Nuexco converts SWU prices at varying tails and product assays to equivalent SWU prices at the DOE Reference Transaction Tails Assay (presently 0.20 weight-percent U_{235}) and a product assay of 3.0 weight-percent U_{235}, assuming feed costs corresponding to Nuexco's Exchange and Conversion Values determined as of the same date.
6. In calculating the Transaction Value, Nuexco does not account for the price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of future Exchange Values or any other indeterminant variable. Also excluded from the calculation are any other transactions in which the delivery price is defined in such a way that it cannot currently be determined.

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EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
Country (currency)	This Month (August 31, 1984)	Last Month (July 31, 1984)	12 Months Ago (August 31, 1983)	This Month (August 31, 1984)	Last Month (July 31, 1984)	12 Months Ago (August 31, 1983)
Australia (dollar)	20.60	21.08	27.28	53.56	54.81	70.93
Belgium (comm. franc)	1,018	1,023	1,294	2,647	2,661	3,364
Canada (dollar)	22.71	23.01	29.58	59.03	59.82	76.90
Finland (markka)	105.87	106.58	137.58	275.23	277.08	357.66
France (franc)	154.87	155.42	194.11	402.62	404.05	504.65
FRG (mark)	50.49	50.64	64.48	131.26	131.64	167.64
Italy (lira)	31,418	31,117	38,523	81,681	80,896	100,152
Japan (yen)	4,220	4,304	5,911	10,971	11,189	15,368
Netherlands (guilder)	56.91	57.23	72.17	147.95	148.78	187.62
South Africa (rand)	27.34	28.62	26.96	71.09	74.40	70.09
Spain (peseta)	2,884	2,861	3,647	7,498	7,439	9,482
Sweden (krona)	145.11	146.81	187.74	377.25	381.68	493.29
Switzerland (franc)	41.96	43.08	52.39	109.08	112.00	136.21
UK (pound)	13.34	13.37	16.02	34.68	34.77	41.64
US (dollar)	17.50	17.50	24.00	45.50	45.50	62.39

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
Country (currency)	This Month (August 31, 1984)	Last Month (July 31, 1984)	12 Months Ago (August 31, 1983)	This Month (August 31, 1984)	Last Month (July 31, 1984)	12 Months Ago (August 31, 1983)
Australia (dollar)	19.31	20.00	26.83	50.19	52.00	69.75
Belgium (comm. franc)	954.04	970.76	1,272	2,480	2,524	3,308
Canada (dollar)	21.28	21.82	26.09	55.32	56.74	75.62
Finland (markka)	99.21	101.10	135.28	257.93	262.83	351.70
France (franc)	145.13	147.42	190.88	377.31	383.27	496.24
FRG (mark)	47.32	48.03	63.41	123.01	124.87	164.84
Italy (lira)	29,443	29,516	37,881	76,546	76,736	98,483
Japan (yen)	3,955	4,083	5,813	10,281	10,614	15,112
Netherlands (guilder)	53.33	54.28	70.97	138.65	141.13	184.50
South Africa (rand)	25.63	27.15	26.51	66.62	70.57	68.92
Spain (peseta)	2,703	2,714	3,587	7,026	7,056	9,324
Sweden (krona)	135.99	139.26	186.58	353.54	362.05	485.07
Switzerland (franc)	39.32	40.87	51.52	102.22	106.24	133.94
UK (pound)	12.50	12.69	15.75	32.50	32.98	40.94
US (dollar)	16.40	16.60	23.60	42.64	43.16	61.35

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[1] Calculated using currency exchange rates published in the *Wall Street Journal* on August 31, 1984.

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CURRENT MARKET DATA

CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U as UF_6 This Month (August 31, 1984)	Last Month (July 31, 1984)	12 Months Ago (August 31, 1983)	per kg. U as UF_6 This Month (August 31, 1984)	Last Month (July 31, 1984)	12 Months Ago (August 31, 1983)
Australia (dollar)	0.94	0.00	1.25	2.08	0.00	2.76
Belgium (comm. franc)	46.54	0.00	59.30	102.60	0.00	130.73
Canada (dollar)	1.04	0.00	1.36	2.29	0.00	2.99
Finland (markka)	4.84	0.00	6.31	10.67	0.00	13.90
France (franc)	7.08	0.00	8.90	15.61	0.00	19.61
FRG (mark)	2.31	0.00	2.96	5.09	0.00	6.52
Italy (lira)	1,436	0.00	1,766	3,166	0.00	3,893
Japan (yen)	192.91	0.00	270.94	425.29	0.00	597.31
Netherlands (guilder)	2.60	0.00	3.31	5.74	0.00	7.29
South Africa (rand)	1.25	0.00	1.24	2.76	0.00	2.72
Spain (peseta)	131.84	0.00	167.17	290.66	0.00	368.55
Sweden (krona)	6.63	0.00	8.70	14.62	0.00	19.17
Switzerland (franc)	1.92	0.00	2.40	4.23	0.00	5.29
UK (pound)	0.61	0.00	0.73	1.34	0.00	1.62
US (dollar)	0.80	0.00	1.10	1.76	0.00	2.43

SWU VALUES EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU FY85 (August 31, 1984)	DOE SWU FY85 (July 31, 1984)	Non-DOE SWU delivery within 15 months (August 31, 1984)	Non-DOE SWU delivery within 15 months (July 31, 1984)
Australia (dollar)	117.72	114.46	100.06	102.41
Belgium (comm. franc)	5,817	5,556	4,945	4,971
Canada (dollar)	129.75	124.90	110.29	111.75
Finland (markka)	604.96	578.56	514.22	517.66
France (franc)	884.96	843.69	752.21	754.88
FRG (mark)	288.52	274.88	245.24	245.95
Italy (lira)	179,533	168,919	152,603	151,138
Japan (yen)	24,114	23,364	20,497	20,905
Netherlands (guilder)	325,20	310.66	276.42	277.96
South Africa (rand)	156.25	155.36	132.81	139.00
Spain (peseta)	16,480	15,533	14,008	13,898
Sweden (krona)	829.19	796.98	704.81	713.09
Switzerland (franc)	239.75	233.87	203.79	209.26
UK (pound)	76.22	72.60	64.79	64.96
US (dollar)	100.00	95.00	85.00	85.00

[1] Calculated using currency exchange rates published in the *Wall Street Journal* on August 31, 1984.

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CURRENT MARKET DATA

RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
3110	1984	50-100	93	European Entity	US Utility	
3103	1984-85	601-1,000	97-103	Canadian Producer	US Utility	
3091	1984	50-100	unknown	European Broker	US Utility	UF_6.
3088	1984	101-300	indeterminate	US Producer	US Producer	Price related to market.

Secondary Market Enrichment Services

Nuexco Transaction Number	Delivery Period[2]	Approximate Quantity[3] (thousands of SWUs)	Approximate Price[4] as Percent of Current SWU Value[5]	Seller Group	Buyer Group	SWU Origin	Remarks
3106	1987-89	301-600	106-135	European Entity	US Utility	Eurodif	Fixed prices. Tails assay 0.20%-0.29%.
3102	1986	101-300	see remarks	European Utility	US Utility	DOE	Discount off DOE price.
3090	1984	less than 50	100	US Utility	US Utility	DOE	0.26% tails assay.
3084	1985	50-100	104	US Utility	European Trader	DOE	0.3% tails assay. Deenrichment swap.
3076	1986	50-100	100	European Entity	US Utility	Eurodif	
3075	1986	50-100	105	US Utility	non-US Utility	DOE	

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[1] Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.

[2] Refers to calendar year, not fiscal year.

[3] If tails assay is unknown or unspecified, Nuexco's calculation of SWU quantity assumes 0.20 w/o tails assay.

[4] Price is not normalized to 0.20% tails assay.

[5] Refers to SWU Value for same origin as SWUs included in transaction.

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CURRENT MARKET DATA

URANIUM SUPPLY
(As of 8/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
1575*	500	500 per year	
1818	—	500 per year	1985-90
1860*	400	1,500 per year	
2038*	1,000	1,000 per year	UF_6
2201*	300	—	
2236	—	200 per year	1985-89
2263	—	500 per year	1985-90
2275*	150	—	
2288	45	—	UF_6
2326*	—	1,000 per year	1989-91
2336	—	250 per year	
2368	—	2,800	
2392	35	—	UF_6
2429*	800	—	
2484	130	—	
2489	—	500	1986-90
2499*	15	—	
2509	1,200	1,600	UF_6
2521*	80	100	U_3O_8 or UF_6
2565	400	—	
TOTAL:	5,055		
INACTIVE			
0564	—	1,000 per year	1985-90
2191	125	—	UF_6
2193	—	800 per year	1986-90
2271	—	500 per year	1984-88
2297	—	200 per year	1985-89
2389	300	—	
2473	—	500 per year	1984-90
2495	130	—	UF_6
2514	—	1,000 per year	
2553	300	—	
2556*	350	—	UF_6
TOTAL:	1,205		

*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.
Projects removed since last month: 2315.

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URANIUM DEMAND
(As of 8/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase: ACTIVE			
2217	—	1,000 per year	1988-95
2506	50	—	U_3O_8 or UF_6
2528	—	250 per year	1991 on
2555*	—	150 per year	1986-89
2563*	1,000	—	UF_6
TOTAL:	1,050		
INACTIVE			
1999	—	50 per year	1985-90
2244*	—	350 per year	1987 on
2329*	—	500	1985
2414	—	150 per year	1987-91
2442	—	250 per year	1986 on
2457*	—	350 per year	1988 on
2507	—	300	1987-88
2542A*	—	1,400	1990; UF_6e
TOTAL:	—		

*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.
Projects removed since last month: 2352, 2456.

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CURRENT MARKET DATA

LOAN SUPPLY AND DEMAND
(As of 8/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Within 1 Year	Beyond 1 Year	Remarks
Available for Loan:			
INACTIVE			
1938*	2,000	—	UF_6
2128*	500	—	
2139*	2,000	—	
2483*	550	—	
TOTAL:	5,050		

*New or revised since last month.

[1] Measured from the date of this Report.

CONVERSION SUPPLY AND DEMAND
(As of 8/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF_6) Within 3 Years	Beyond 3 Years	Remarks
Available for Sale:			
ACTIVE			
2141	2,600	—	
2560*	225	—	
TOTAL:	2,825		
INACTIVE			
2051	1,000	—	
2401	600	—	
2438	500	250	1985-87
2511	600	700	1986-90
TOTAL:	2,700		
Inquiries to Purchase:			
ACTIVE			
2456B*	845	—	
TOTAL:	845		
INACTIVE			
2420*	300	—	1986
TOTAL:	300		

*New or revised since last month.

[1] Measured from the date of this Report.

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CURRENT MARKET DATA

SWU SUPPLY AND DEMAND
(As of 8/31/84)

Nuexco Project Number	Delivery Period[1] (Thousands of SWUs) Spot or Near-term[2]	Intermediate or Long-term	Remarks
Available for Sale:			
ACTIVE			
2100	—	100 per year	1986-87
2164	80	—	
2285	—	1,000	
2408*	—	65	1986
2428*	80	40	
2513*	—	25	1986
2550	55	—	
TOTAL:	215		
INACTIVE			
2192	10	—	
2510*	200	—	
TOTAL:	210		
Projects removed since last month: 2345. 2351.			
Inquiries to Purchase:			
ACTIVE			
2443*	70	—	
2452	30	—	1985
2454*	100	100	1986
2471*	—	40 per year	1986-90
2503	—	330	1986
2519	—	30 per year	1987 on
2543	10	20	1986
2562	15	30	1986
2564*	—	30	1986
2600*	100	—	
TOTAL:	325		
INACTIVE			
2449*	—	50	1987 on
2459*	—	50 per year	1987 on
2479	—	50	1986
2480*	100	—	
2512	—	15 per year	1987 on
2542B*	—	340	1990; UF_6e
2552	35	—	
TOTAL:	135		

*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

Projects removed since last month: 2346. 2407. 2430. 2522.

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COMMENTARY

THE ROLE OF THE US GOVERNMENT'S URANIUM ENRICHMENT PROGRAM

by **J.R. Wolcott,** *Chairman and Chief Executive, Nuexco*

On August 16, 1984, J. Robert Wolcott testified before the Tricommittee Advisory Panel on Uranium Enrichment for the US House of Representatives, in Washington, D.C. The Advisory Panel consists of eight persons selected from outside the government, and was asked by the Congress to provide a report assessing the US enrichment program to the three congressional committees that influence enrichment policy and program funding. Mr. Wolcott's remarks are summarized below.

Nuexco provides brokerage, consulting and information services to clients having interests in the nuclear fuel market. Approximately two-thirds of Nuexco's business involves non-US companies. The policies and practices of the US DOE have a wide influence on the international market, and thus on Nuexco's business.

The theme I would like to concentrate on today is the need for a clear definition of the role of the US government's uranium enrichment program in the international market. I do not believe there is a universally accepted view of what that role is, or should be. The Congress, US utilities, and non-US utilities all have an interest in a clear and common understanding.

At the present time, the US government is attempting to increase (or at least maintain) its share of the international enrichment business. To achieve this goal, the government is combatting nationalism and competition with price reductions, while developing new technologies on a large scale. A clear definition of the role of the US enrichment program could demonstrate that the current set of market practices is not preferable.

Alternative Missions

The government needs to define a specific mission for DOE. In my view, there could be three options.

1. To operate as a *business*. The major indicators of business success are profitability, return on investment, and cash flow. Unfortunately, DOE cannot operate effectively as a private enterprise in the existing governmental environment. Political and institutional constraints and conflicts are too great. If DOE were to operate as a business, fundamental institutional restructuring would be necessary.

2. To operate as a *political instrument*. The primary mission would be to influence and control the policies of domestic companies and other nations. Political influence would outweigh economic results. In today's market, such a mission is impractical, because uranium enrichment technology is well-developed in at least eight countries outside the USA. In the past, attempts by the USA to control other nations' policies have been counterproductive. As for US companies, it is clear that they appreciate the services of the government, but resent overregulation or market obstruction.

3. To provide a *national service*. The mission would be to provide, effectively and efficiently, a national service that is not otherwise available. In my opinion, DOE should concentrate on this alternative—providing a high-quality national service. It is the only practical mission. Growth and bigness do not necessarily serve this purpose.

The Market for DOE's Services

There is an undeniable, apparent trend in other nations towards fuel supply independence. There are three successful commercial enrichment enterprises in Europe alone, and production facilities exist in five European nations. A production operation is being organized in Japan that will be owned by the Japanese utilities, the customers. Clearly, a private business in DOE's position would not plan its programs and investments on the assumption that a large foreign market for its services will continue. The plans would assume a declining non-US market.

Most US utilities prefer to take their enrichment services from DOE almost regardless of price. I see no possibility that DOE will not remain the dominant US supplier. There will be a large market for US enrichment services regardless of events outside the USA. The uncertainty facing DOE is not one of *survival;* it is one of *size*.

Competition for the US market has been beneficial. It has forced DOE to reduce costs and improve services. Secondary market competition, sales of enriched uranium and SWU commitments from users, has probably passed its peak, but it will continue and will provide a measure of market discipline. Primary market competition, long-term sales from non-US enrichment enterprises to traditional DOE customers, has only recently begun, but it also will continue to provide market discipline. I believe competition is a permanent and healthy feature of the international enrichment market.

Pricing

As part of its strategy of taking the offensive against other SWU sellers, DOE has recently discussed incremental, or marginal-cost, pricing. By definition, such pricing does not provide full-cost recovery. The media has inferred that DOE may sell SWUs in the range of $60-$80

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to be competitive with non-US SWU sellers.

It is difficult to understand the rationale for this strategy. Essentially, it reduces the cost of power for non-US manufacturers (the users of the power) while providing no tangible benefit—and potentially a large loss—to the US government. The difference between full cost and marginal cost must be recovered, in accordance with the prevailing law. Charging less than full cost now means that long-term customers of DOE must ultimately make up for losses. The only reliable long-term customers are US utilities.

Moreover, the USA from time to time has accused non-US suppliers of "dumping" on the US market. It seems to me there is an inconsistency in our position that needs an explanation. Can dumping by non-US companies be criticized fairly at the same time that DOE promotes marginal-cost pricing overseas?

Competition among the primary enrichment suppliers yields what I would call soft pricing. Governments control all of the suppliers, and none likes to retreat from a challenge. DOE, the highest-cost, highest-volume producer and the market leader, is now promoting a downward price spiral. In the past, every time DOE has made competitive price concessions that are expensive for the government, the competition has followed. DOE needs to exhibit price leadership in accordance with a clearly-defined mission.

Research, Development and Investment

A SWU is a SWU, no matter who produces it or by what method. The only practical focus of research and development is *cost reduction*. Before large investments in commercial-scale facilities are made, production costs for alternative processes must be known. Test facilities must provide the basis for accurate cost estimates. Moreover, institutional and organizational costs must be weighed. Different enrichment programs entail different management, labor, and political costs that are not technically dependent. Research and development programs must focus on providing accurate cost comparisons at the earliest date and at minimum cost.

The R&D programs should be examined from that point of view. Organizations can become caught up in the pursuit of expensive new technologies. We need to avoid a situation in which *theoretical* costs based on basic research are compared to *actual* costs based on truly relevant experience. The pace at which funding is provided for centrifuge and laser technology should be synchronized so that answers about costs come from both sources at approximately the same time. Those answers can be compared with the costs of the existing production method.

Conclusions

1. The theme I hoped to stress today was the need for a clear definition of the role of the US government's enrichment program, particularly in the international market. Is the enrichment program to function as a business, an instrument of policy, or a public service? One can neither criticize nor praise the program fairly unless one has a basis of measurement. That basis should be defined with a specific mission.

Once the mission is clarified, a number of questions can be answered, including:

How important is program size and market share?

What is the optimum production level? Which plants should be operated?

What are proper pricing strategies for US and non-US utilities? What does the US gain from them?

When should new facility investments be made? Who benefits from those investments?

2. DOE's problems are not unique. They are the result of the drying up of overseas markets with the growth of nationalistic competition. Numerous private businesses have gone through this evolutionary process. Many have adjusted and survived. DOE will survive more easily because of its strong base of nationalistic support.

3. There is always a danger of overreaction in a situation such as that facing the US government's enrichment program. It is a popular instinct to assume that "a good offense is the best defense." But that may not be the wisest approach. An organization such as DOE must constantly reevaluate its mission and formulate its strategy on the basis of its mission.

A Suggestion

I find in my own company that a board of directors including persons from outside the company is most useful. It focuses attention on the broader goals of the organization. It serves as a constant reminder to management that the aim of the business is not to serve management. It provides a perspective that those of us submerged in day-to-day operations do not always have.

An equivalent body may be useful to the US government. The purpose could be much the same as for a business corporation: evaluating policies and strategies, evaluating performance, representing shareholders' (taxpayers in this instance) interests. Perhaps with such an oversight body Congress would give DOE greater policy latitude and flexibility, which I believe it needs.

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ENRICHED URANIUM SALES: EFFECT ON URANIUM SUPPLY INDUSTRY

by **Richard K. Andersen,** *Vice President, Nuexco*

The following is a slightly edited version of a presentation made by Dick Andersen at the Uranium Institute's Ninth Annual Symposium in London on September 7, 1984.

Overview

Two recent unanticipated events have reduced by approximately 130 million pounds the previously expected demand for U_3O_8 during the period 1983–91. The two unexpected events have been:

1. secondary market sales of low-enriched uranium (LEU) inventories;
2. the offer of the Utility Services enrichment contract (USEC) by the US Department of Energy (DOE).

Nuexco's analysis indicates that 12 million pounds of the 130 million pound total potential demand reduction has already affected the U_3O_8 market, and that the remaining 118 million pounds could do so over the next seven years. Three principal market changes are causing this reduction.

1. The elimination of artificial demand created by prior enrichment contracts having fixed-commitment terms;
2. The net drawdown of existing inventories held by DOE customers;
3. Purchases of LEU on the secondary market by USEC customers from other holders of inventory.

Table 2 summarizes the effect of each of these three market changes on uranium demand expectations, as measured by feed delivery commitments to DOE in the Fall of 1983. Figure 1 illustrates the artificial demand created by prior DOE contracts (48 million pounds); Figure 2 illustrates the difference between reactor consumption and feed commitments under the USEC (70 million pounds)—a difference that can be compensated for by inventory reductions and sales of LEU on the secondary market. Figure 3 illustrates the total effect of the USEC on prior demand expectations (118 million pounds).

The extent to which (a) users actually reduce existing inventories, and (b) LEU is redistributed among users in the secondary market, will not be influenced simply by macroeconomic forces. Political and business factors affecting each user ultimately control the extent of market change. However, the overall implications for the uranium market of the market changes outlined above are clear.

1. The market price should remain relatively depressed for the next few years due to reductions in feed commitments and the overall drawdown of user inventories.
2. Thereafter the market for the supplier industry will be better defined, and a period of general stability will ensue.

Table 2

COMBINED EFFECT OF USEC TERMS AND LEU INVENTORY SALES ON U_3O_8 DEMAND, 1983–1991

Market Trend	Millions of Pounds U_3O_8
Elimination of artificial demand created by prior DOE contracts	48
Net drawdown of existing inventories held by USEC customers	38
Purchases of LEU by USEC customers from other holders of inventory	32
TOTAL	118

Development of LEU Inventories

Inventory accumulates at each stage of the nuclear fuel cycle. To understand the nature of demand, uranium suppliers must observe continually the flow of uranium through the stages and monitor the inventory accumulations.

For over a decade, the enrichment services market was served largely through fixed-commitment contracts. DOE offered a rigid type in 1973 and a somewhat more flexible type in 1979. The European enrichers, Eurodif, Urenco and Techsnabexport, usually contracted on a fixed-commitment basis as well. As a result, enrichment services (SWU) production exceeded consumption for many years, and resulted in the accumulation by users of large inventories of uranium in various forms.

The current size of LEU inventories can be gauged as a subset of total inventories. Commercial WOCA[1] inventories of U_3O_8, natural UF_6 and LEU are estimated by Nuexco at about 430 million pounds U_3O_8 equivalent by the end of 1984. This amounts to 4.5 years of forward con-

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[1] *World Outside Centrally Planned Economic Areas.*

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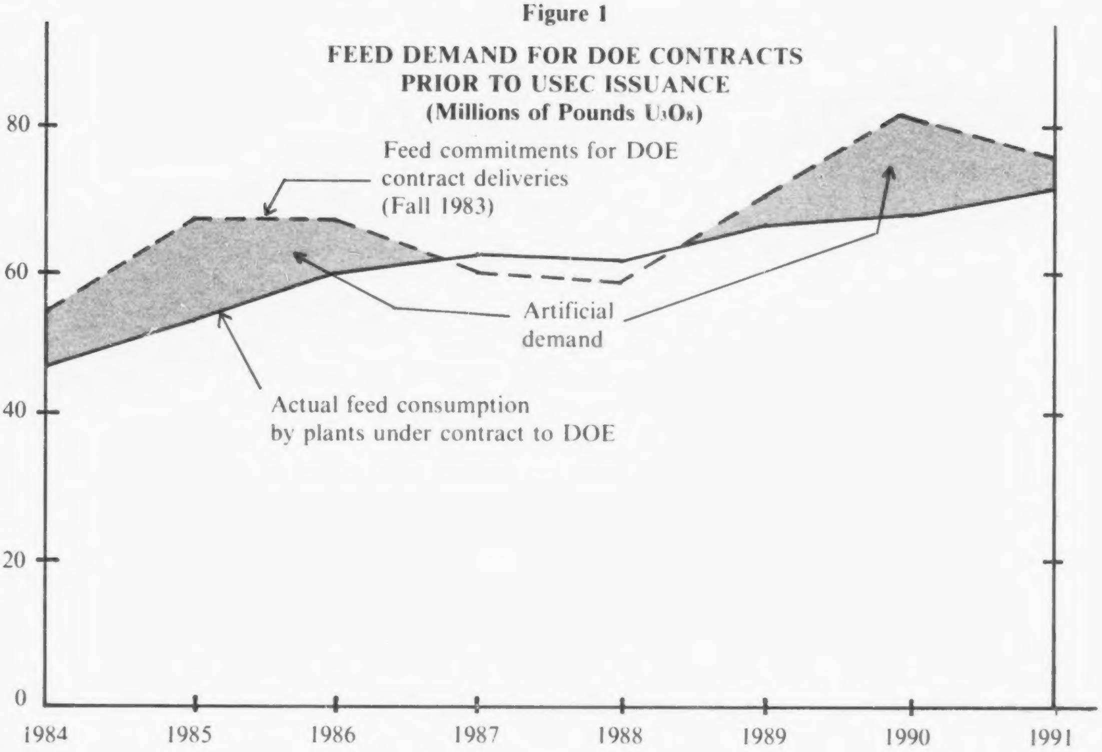

Figure 1

FEED DEMAND FOR DOE CONTRACTS PRIOR TO USEC ISSUANCE (Millions of Pounds U_3O_8)

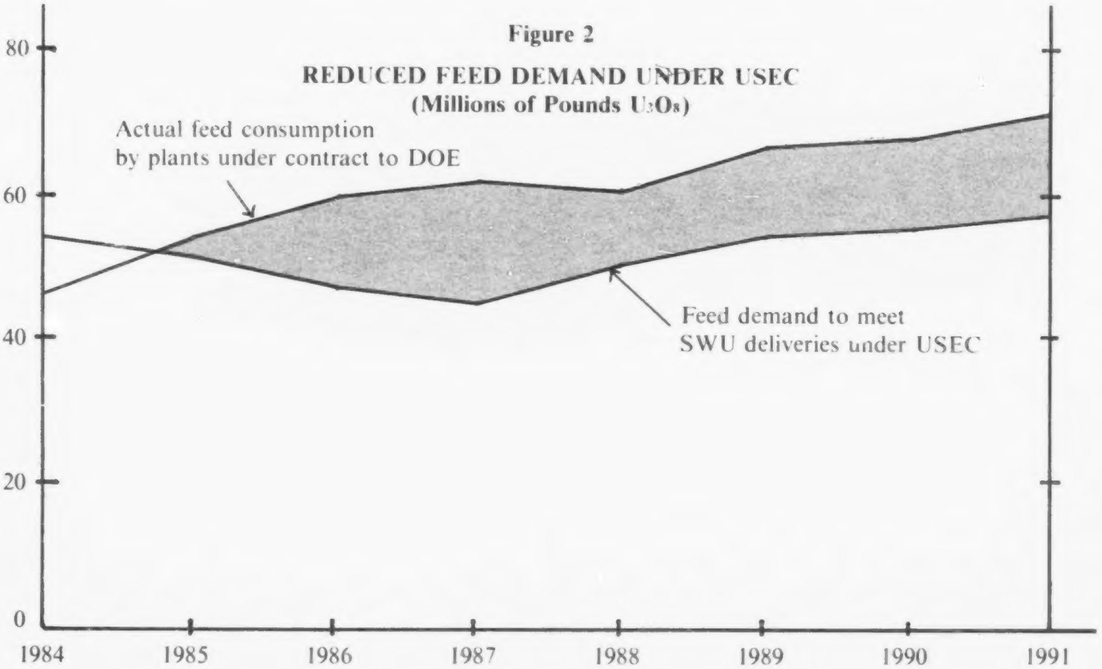

Figure 2

REDUCED FEED DEMAND UNDER USEC (Millions of Pounds U_3O_8)

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sumption given current forecasts of nuclear power use. Of these inventories, the LEU portion is about 44 percent (190 million pounds U_3O_8 equivalent), just over 2 years of forward consumption.

Inventory holders accumulated excesses for different reasons. Some national entities had joined France in the ownership of the Eurodif enrichment plant based on expectations of large nuclear programs. As these programs failed to materialize, LEU inventories began accumulating in Europe. In the USA, as nuclear plants were delayed or canceled, many utilities also accumulated LEU inventories. Utilities that canceled all their nuclear plants had no need for their inventories and sold them. Utilities that encountered long plant construction delays have to date not sold LEU, but this is expected to change soon. Large LEU inventories also accumulated in Japan, where security of supply is an important consideration.

With additional deliveries arriving and others scheduled to arrive, buyers made attempts to curtail inventory growth. Eurodif reduced production and renegotiated some delivery schedules. Following these adjustments, it was expected that inventories gradually would be consumed by their owners. The development of a large LEU secondary market was not generally anticipated.

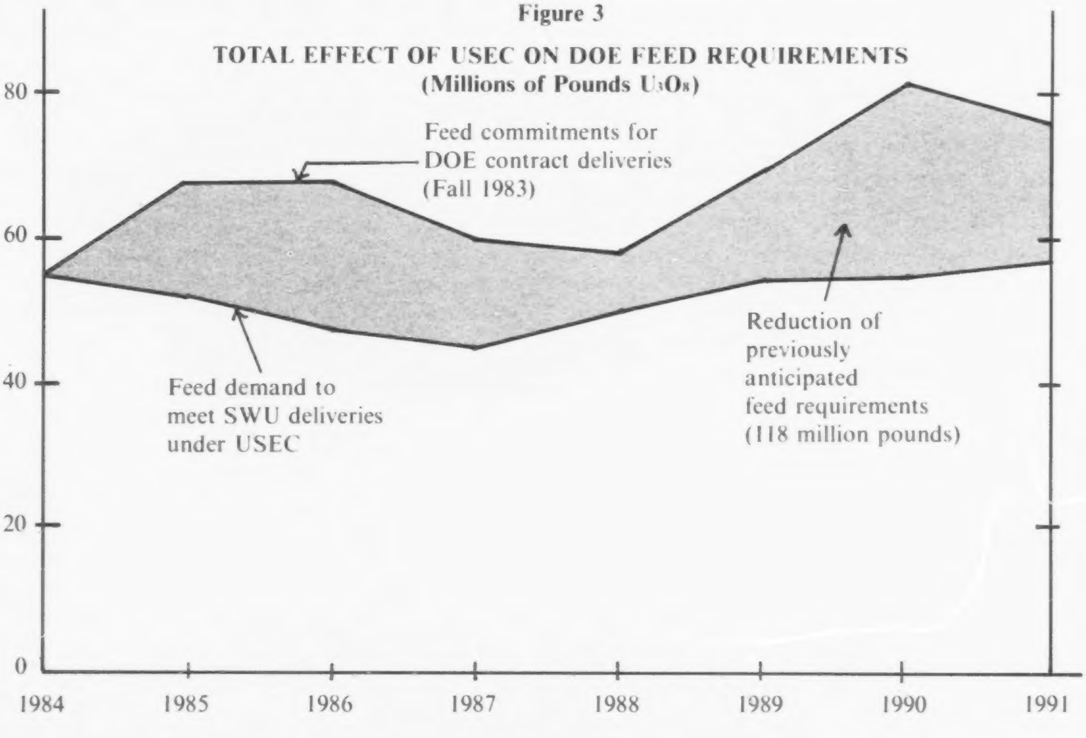
However, holding large excess LEU inventories is expensive. In early 1983, a few inventory holders elected to offer LEU at low prices. Those prices were sufficiently low that certain DOE customers found it profitable to cancel and pay termination penalties on their enrichment deliveries, and then buy from inventory sellers on the secondary market. This created a market outlet for excess material. Other inventory holders began to participate in the market, and LEU inventory selling gained momentum. To date, about 12 million pounds U_3O_8 equivalent have been sold on the secondary market as LEU or as its natural UF_6 component.

Effect of USEC

As secondary market selling of inventories gained momentum, DOE became increasingly alarmed at its lost enrichment business. It tried several methods to curtail delivery terminations. In January 1984, it issued the USEC,

Figure 3

TOTAL EFFECT OF USEC ON DOE FEED REQUIREMENTS
(Millions of Pounds U_3O_8)



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a requirements-type contract. The USEC was developed to stabilize business and sustain future revenue. The issuance of the USEC had the immediate effect of causing contract holders to stop procurement activities and evaluate future desired action, thus slowing the rate of LEU inventory sales.

The USEC will have lasting effects on the U_3O_8 market. In the longer term, it will assist in stabilizing the uranium market, because feed requirements will be more closely matched to reactor consumption. In the shorter term, it will allow utilities to delay the procurement of natural uranium.

There are six anticipated changes in the uranium market, including the three enumerated in Table 2, caused by the USEC. Four changes are negative for the supplier industry, one has little effect, and the last slightly helps U_3O_8 suppliers outside the USA.

1. The USEC eliminates artificial demand driven by DOE fixed-commitment enrichment contracts, thus *reducing* utilities' current and future U_3O_8 needs to the level of uranium consumption in their power plants.

2. It facilitates the drawdown of existing LEU inventories, either under the specified terms of conversion to the USEC or through additional concessions made by DOE in contract negotiations, again *reducing* the utilities' future U_3O_8 needs where excess inventories are available.

3. It permits the purchase of LEU inventories after 1986 in amounts up to 30 percent of requirements without termination charges, thus providing an opportunity for *reducing* U_3O_8 supplier sales.

4. It requires the payment of a premium for a buyer's election of a tails assay higher than 0.20 weight percent, although this will probably have only a small effect on U_3O_8 feed requirements.

5. It has resulted in the delay of some U_3O_8 purchases until utilities decide whether to convert to the USEC, thus invoking an unexpected moratorium on U_3O_8 purchases for many utilities through most of 1984.

6. The prospect of US sales has led European enrichers to make attractive offers to US utilities, thus broadening the utilities' commercial perspectives and somewhat reducing their inherent "Buy American" attitudes.

It can be argued that, had DOE not issued the USEC, secondary market sales of LEU material would have continued unabated with worse near-term effects on U_3O_8 sales. The USEC provides important relief mechanisms by which many utilities can:

1. delay LEU deliveries and, as a consequence, U_3O_8 feed procurement;

2. purchase LEU material, thus allowing inventory sellers to compete with other suppliers.

The following paragraphs review each of the principal effects, so as to provide clearer perspective on the role of LEU inventory sales and the DOE offer of the USEC.

Elimination of Artificial Demand

The USEC was designed as a requirements contract to entice all existing contract holders to convert to uniform terms. It gradually reduces the overcommitments of prior (Adjustable Fixed-Commitment) contracts. For those utilities electing to contract for 100 percent of their needs under the USEC, deliveries should closely match nuclear plant consumption. Figure 1 compares the worldwide U_3O_8 feed deliveries expected by DOE in the Autumn of 1983 with estimated U_3O_8 consumption by plants under DOE contract.

The USEC reduces U_3O_8 requirements associated with enrichment contracts by about 48 million pounds U_3O_8 over the seven-year period from 1985 to 1991. This reduction is equivalent to about 6 months of current worldwide U_3O_8 production. The artificial demand, had it occurred, would have resulted in inventory buildup. To work off that inventory it would have had to be applied against reactor consumption in later years. Thus, long-term demand is stabilized by the short-term drawdown of inventory created by artificial demand.

In the Autumn of 1983, anticipated DOE delivery commitments in later years might have been too optimistic. Some of the artificial demand three or more years into the future might have been terminated in any event, and, to that extent, the 48 million pounds U_3O_8 is overstated somewhat.

Drawdown of LEU Inventories

An attractive feature of the USEC is the option to purchase less than full SWU requirements. The contract terms, with certain restrictions, permit the utility to select between 70 and 100 percent of its needs. In addition, during contract negotiations, DOE has made concessions for less than 70 percent of deliveries in earlier years in exchange for larger deliveries in later years.

Allowing for restrictions and expected negotiated agreements, Nuexco judged that DOE contract holders in the USA and the Far East would contract from DOE for about 80 percent of requirements in 1985, 72 percent in 1986, and 85 percent in 1987 and beyond. Most European holders of DOE contracts were expected not to convert to the USEC.

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Thus, DOE contract holders with excess inventories will likely commit for less than 100 percent of their requirements in certain years. They can then draw down their inventories in those years. The drawdown reduces the current need for enrichment services and associated U_3O_8 requirements.

The worldwide effect of DOE feed requirements under the USEC compared with consumption for these contract holders is shown in Figure 2. The difference between the two curves amounts to about 70 million pounds U_3O_8 equivalent over the seven-year period. Of that amount, Nuexco estimates net drawdown of user inventories at 38 million pounds U_3O_8 equivalent.

Over the forecast period, there are some utilities that will draw down while other utilities will build up inventories. Drawdown comes from each utility's consumption of its own existing LEU inventories. Nuexco estimated the amount attributable to inventory drawdown at about 50 million pounds U_3O_8. Inventory buildup occurs where certain utilities have DOE commitments in 1984 and 1985 in excess of their needs. For some utilities, conversion to the USEC will not fully relieve these commitments. Note in Figure 2 that DOE deliveries in 1984 exceed consumption. This buildup of inventories amounts to about 12 million pounds U_3O_8. Thus the net inventory change is a drawdown of about 38 million pounds U_3O_8 over the seven-year period.

Purchase and Sale of LEU Inventories

After drawdown of their own LEU inventories to acceptable levels, utilities will have to make purchases to meet future unfilled enrichment requirements. Nuexco estimates those unfilled requirements for DOE contract holders to amount to 32 million pounds U_3O_8. Those unfilled requirements make up the balance of the 70 million pound difference between the two curves in Figure 2.

Utilities tend to buy their near-term needs on the spot market, while contracting for the longer term with primary suppliers. Over the next few years, a prominent source of enrichment services and natural uranium to meet unfilled requirements will be sellers of LEU inventory. They will compete by discounting their prices below the prices of primary suppliers in order to make spot sales.

Macroeconomic studies of this type depend for accuracy on rational economic actions by the industry participants. Unfortunately, inventory sellers are motivated not only by economics, but by political and other business factors. Thus, it is difficult to predict which inventory holders will sell, how much will be sold, and in what years. In broad terms, Nuexco expects that LEU sales by inventory holders will originate in Europe and the USA, but not in the Far East.

The market is further complicated in the period before 1987, when most USEC holders are obligated to purchase only DOE-origin SWUs. All others, including some USEC holders who terminated DOE deliveries in 1983 or earlier, can purchase non-DOE SWUs. Thus, buyers and sellers need to be matched between DOE and non-DOE origin SWUs to determine the magnitude of sales in each year.

Even so, the analysis shows there will be more inventory sellers of both DOE and non-DOE SWUs in the period before 1987 than there will be buyers of either type. Consequently, not all sellers will be able to find buyers for the delivery of material in the year desired. Advance sales will occur where deliveries are made in years subsequent to the year of sale. Due to the lack of buyers, accumulated inventories will be pushed forward in time until the market can absorb the available material offered.

Thus, inventory sales through 1987 will be controlled by buyers functioning under rational economic factors. Sales beyond 1987 are more problematical. They could be higher than estimated, since Nuexco's analysis postulated inventory selling only by the most plausible sellers. World inventory sales, by year of delivery, are estimated in Figure 4. Their cumulative total is about 55 million pounds U_3O_8 equivalent, with about one-half involving DOE-origin SWUs and one-half non-DOE SWUs.

Of the 55 million pounds U_3O_8 equivalent sold, it is expected that about 60 percent (32 million pounds equivalent U_3O_8) will be sold to DOE contract holders. The remaining 40 percent will be sold to others in Europe and other nations of the world.

Tails Assay Option

The tails assay option has a small effect on U_3O_8 feed deliveries under the USEC. Under the prior DOE contracts, one type of contract (Requirements) representing about one-half of the DOE deliveries, required a tails assay election of 0.20 w/o U_{235}. The other type of contract (Adjustable Fixed-Commitment), representing the second half of DOE deliveries, provided for a tails assay election of 0.16 to 0.30 w/o U_{235}. At current low U_3O_8 prices and high SWU prices, many utilities with the latter contract type were electing tails assays near the upper limit. The net effect was an average tails assay of about 0.25 w/o for DOE contract holders.

Under the USEC, all contract holders can elect a variable tails assay after 1986. However, for tails assay elections above 0.20 w/o, the USEC calls for a premium pay-

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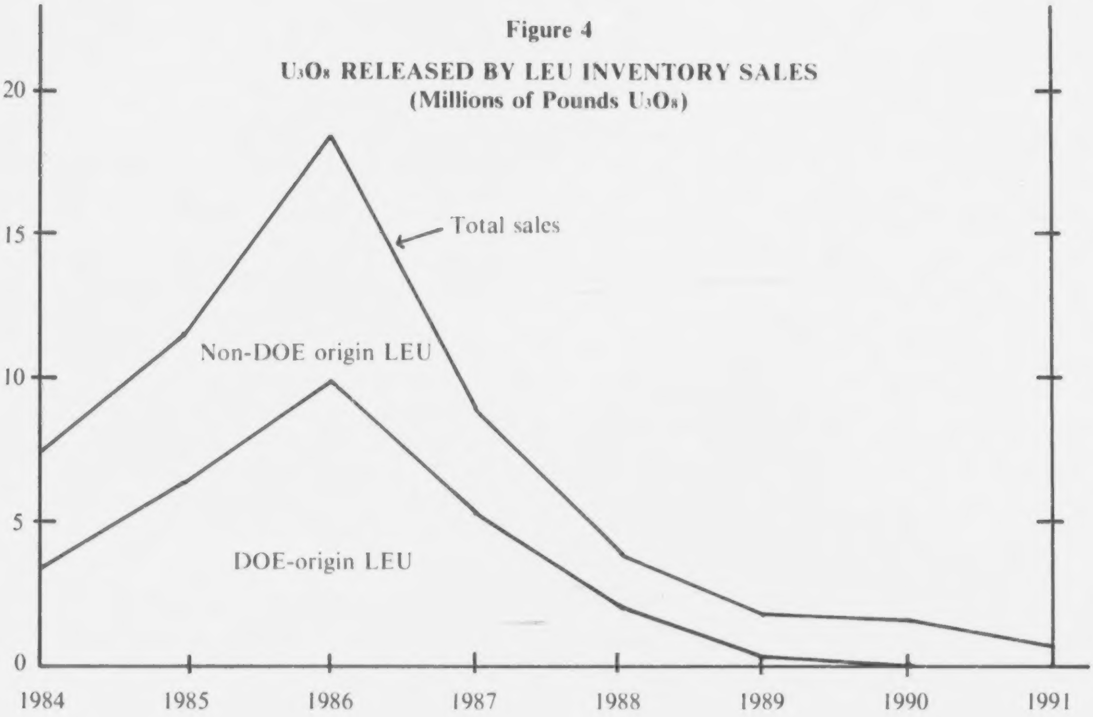

Figure 4

U_3O_8 RELEASED BY LEU INVENTORY SALES
(Millions of Pounds U_3O_8)

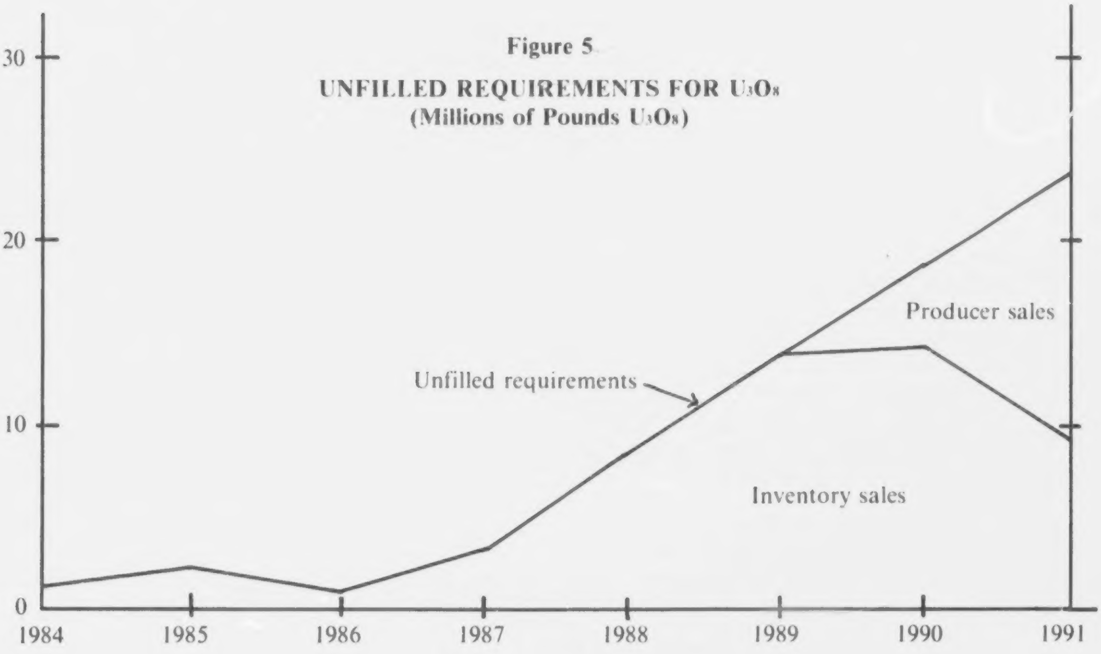

Figure 5

UNFILLED REQUIREMENTS FOR U_3O_8
(Millions of Pounds U_3O_8)

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ment. The effect of the premium is to reduce the optimum tails assay. The premium will influence all USEC holders to select a tails assay of about 0.24 w/o U_{235}. The effect of the reduction from 0.25 to 0.24 w/o U_{235} is negligible in comparison with other USEC effects.

Had the premium not been included in the USEC, the optimum tails assay, based on previous experience, would have been about 0.28 w/o U_{235}. This would have increased feed requirements by about 35 million pounds U_3O_8.

Unfilled Requirements for U_3O_8

Uranium suppliers are principally interested in U_3O_8 unfilled requirements in the WOCA nations. A forecast of unfilled requirements, allowing for inventory drawdown, is shown in Figure 5. The unfilled requirements for U_3O_8 will be satisfied either by inventory sales or by primary producer sales. World producers will have to compete with inventory sellers until those inventories are redistributed to others.

The projection of 55 million pounds U_3O_8 equivalent of expected worldwide LEU inventory sales could satisfy unfilled enrichment and U_3O_8 requirements well into the future. There is no practical way of predicting the distribution of unfilled enrichment requirements among inventory sellers and primary enrichers. Since inventory sellers generally offer lower prices to stimulate spot sales, it can be assumed that inventory sellers will gain a large share of the market in the near term.

Inventory sellers could place enough material on the spot market to satisfy most unfilled U_3O_8 requirements through 1989 (Figure 5). U_3O_8 supplier sales will take an increasing share of the unfilled requirements in 1990 and beyond. The assumptions used in Figure 5 are undoubtedly extreme, since some portion of unfilled requirements will be filled by U_3O_8 supplier sales in earlier years. These suppliers will win sales in competition with inventory sellers. As a result, inventory sales will stretch well into the 1990s. It is Nuexco's opinion that some form of secondary market will always exist to redistribute excess inventories that accrue from discrepancies in the scheduling of power plants.

Conclusions

The dynamics and disruptions of the marketplace tend to invalidate long-term quantitative forecasts. The forecasts only predict a rational market up to the time of the next major market discontinuity. With an enrichment market in turmoil, this paper draws only two conclusions. The U_3O_8 market will continue to be depressed until:

1. Sellers dispose of their large undesired LEU inventories;
2. Other holders draw down their LEU inventories to a desired level.

These actions probably will depress the U_3O_8 market for several years. It will not last as long as the results of this analysis indicate, since utilities will again anticipate the future and begin to buy U_3O_8 in advance of an expected price rise.

The benefit to the U_3O_8 suppliers comes in the longer term. The USEC will cause DOE to operate its enrichment plants during the 1980s at a level below actual customer consumption levels. With both Eurodif and DOE reducing plant loads, undesired excess inventories can be eliminated, and a new era of stability can come to the uranium supply industry.

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US AND EUROPEAN UTILITY URANIUM PURCHASES, 1979-84

Introduction

US and European utilities currently receive most of their uranium under longer-term contracts signed during the 1970s. Since 1980, longer-term contracting has been modest compared to previous years, while spot and nearer-term purchasing has increased. US utilities have diversified their sources after years of almost total reliance on US producers. In recent years, both US and European utilities have purchased large amounts of uranium from Canadian producers and from other sellers, such as utilities, traders, and national fuel companies not counted among the world's conventional producers.

These conclusions draw support from an analysis of 173 uranium purchases by US and European utilities reported by Nuexco between February 1979 (Report 126) and August 1984 (Report 192). Those transactions constitute approximately half of the uranium sales transactions reported by Nuexco during that time period (66 months), the balance being purchases by other utilities, by producers, and by companies which are not the end users of the uranium they buy. Transactions reported by Nuexco may not include all transactions closed during a referenced time period; nor does Nuexco specify the origin of the material sold.

Longer-term Contracts

Table 3 presents an analysis of the transactions reported that involved longer-term deliveries. *Longer-term* refers to multiple-year deliveries beginning or extending beyond two years from the date the transaction was reported. Table 3 sorts transactions separately for US utilities and European utilities by seller group and transaction year. (It does not indicate the years that deliveries did or will take place.) The *transaction year* extends from the February Report of one year through the January Report of the following year.

For US utilities, a noticeable statistic is the large number of transactions (11) and large associated quantity of material (24.4 million pounds) concluded in 1979 exclusively with US producers. Since 1979, the 12 reported sales from US producers have involved a total of only 15.4 million pounds, an indication of a sharp drop in demand. To satisfy unfilled requirements, US utilities have diversified their sources of longer-term supply. Eleven transactions with non-US producers and other sellers were reported between 1980 and August of this year, involving a total of 23.9 million pounds. Those figures include six contracts with Canadian producers. Deliveries under two contracts signed at the end of 1983 with an Australian producer are uncertain due to their pricing provisions.

For European utilities, two statistics stand out. One is the almost 50 million pounds contracted in 1980, principally by German utilities, for deliveries from Australia. Deliveries from the Ranger mine for some of the contracts extend for fifteen or more years. The other statistic is the nearly 30 million pounds contracted since February 1982 exclusively with Canadian producers. European utilities customarily have relied heavily on African and Australian producers for their longer-term deliveries, but in recent years no new contracts with these seller groups have been reported.

Traditionally, European utilities' contracts with their principal longer-term suppliers have specified annual price negotiations. Largely because of their reliance on overseas producers, most European utilities have endeavored to maintain mutually agreeable relations with their suppliers. By contrast, US utilities traditionally have solicited competitive bids when contracting for longer-term deliveries, and pricing formulas have been written into contracts rather than negotiated annually.

Because of regulatory fuel-adjustment clauses allowing utilities to recover the market price of fuel in the customer rate base, most US utilities have insisted on market-related pricing provisions for the past several years. Many market-related pricing provisions have used some function of a published nearer-term pricing indicator, such as the Nuexco Exchange Value, the Nukem Price Range, or the Nuexco Transaction Value, singly or in combination. Pressure on utilities from regulatory bodies to pay market prices has engendered less cooperative relations between US utilities and US producers than are found among European utilities and their suppliers; the volume of uranium-related litigation in the USA has been a testimony to that observation.

Nearer-term Purchases

Table 4 presents an analysis of transactions reported that involved nearer-term deliveries. *Nearer-term* refers to single deliveries and to deliveries within one year. Except for 1981 in Europe, when the quantity declined, the volume for material sold to US and European utilities in the nearer-term market has increased steadily since 1979. US utilities have made more individual purchases, but generally of smaller quantities. US producers' share

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ANALYSIS & COMMENTARY

Table 3
US AND EUROPEAN UTILITY URANIUM PURCHASES[1] FOR LONGER-TERM DELIVERY[2] REPORTED BY NUEXCO BETWEEN FEBRUARY 1979 AND AUGUST 1984

	US Utilities			European Utilities		
Seller Group	Thousands of Pounds U_3O_8	Percent of Total Quantity	Number of Transactions	Thousands of Pounds U_3O_8	Percent of Total Quantity	Number of Transactions
1979 Transaction Year[3]						
African producer	0	0	0	3,300	71	2
Australian producer	0	0	0	0	0	0
Canadian producer	0	0	0	400	9	1
US producer	24,445	100	11	900	20	2
Other seller[4]	0	0	0	0	0	0
	24,445	100	11	4,600	100	5
1980 Transaction Year						
African producer	0	0	0	12,780	21	3
Australian producer	500	12	1	48,840	79	6
Canadian producer	0	0	0	0	0	0
US producer	3,330	79	2	300	0	1
Other seller	366	9	1	0	0	0
	4,196	100	4	61,920	100	10
1981 Transaction Year						
African producer	0	0	0	0	0	0
Australian producer	0	0	0	5,200	69	1
Canadian producer	2,750	89	1	2,340	31	1
US producer	330	11	1	0	0	0
Other seller	0	0	0	0	0	0
	3,080	100	2	7,540	100	2
1982 Transaction Year						
African producer	0	0	0	0	0	0
Australian producer	0	0	0	0	0	0
Canadian producer	5,100	57	4	10,280	100	3
US producer	3,875	43	4	0	0	0
Other seller	0	0	0	0	0	0
	8,975	100	8	10,280	100	3
1983 Transaction Year						
African producer	0	0	0	0	0	0
Australian producer[5]	5,400	91	2	0	0	0
Canadian producer	0	0	0	9,702	100	1
US producer	500	9	1	0	0	0
Other seller	0	0	0	0	0	0
	5,900	100	3	9,702	100	1
1984 Transaction Year (first seven months)						
African producer	0	0	0	0	0	0
Australian producer	0	0	0	0	0	0
Canadian producer	1,500	11	1	6,660	100	2
US producer	7,350	56	4	0	0	0
Other seller	4,310	33	2	0	0	0
	13,160	100	7	6,660	100	2

[1] Includes purchases by utility fuel procurement departments only. Excludes purchases by national companies which may sell uranium to utilities.

[2] Refers to multiple-year deliveries beginning or extending beyond two years from the date the transaction was reported.

[3] Transaction year includes transactions listed in the February Report of the referenced year through the January Report of the following year.

[4] Other sellers include utilities, fuel procurement organizations independent of utilities, trading companies, and other organizations not defined as producers. The material they sell may be of any origin.

[5] Deliveries under these contracts are highly uncertain due to floor-price provisions.

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Table 4
US AND EUROPEAN UTILITY URANIUM PURCHASES[1] FOR NEARER-TERM DELIVERY[2] REPORTED BY NUEXCO BETWEEN FEBRUARY 1979 AND AUGUST 1984

	US Utilities			European Utilities		
Seller Group	**Thousands of Pounds U_3O_8**	**Percent of Total Quantity**	**Number of Transactions**	**Thousands of Pounds U_3O_8**	**Percent of Total Quantity**	**Number of Transactions**
1979 Transaction Year[3]						
African producer	0	0	0	260	23	1
Australian producer	0	0	0	0	0	0
Canadian producer	0	0	0	0	0	0
US producer	1,544	93	9	300	27	1
Other seller[4]	110	7	2	554	50	3
	1,654	100	11	1,114	100	5
1980 Transaction Year						
African producer	0	0	0	0	0	0
Australian producer	0	0	0	0	0	0
Canadian producer	0	0	0	500	24	2
US producer	1,299	85	9	840	40	4
Other seller	236	15	2	770	36	4
	1,535	100	11	2,110	100	10
1981 Transaction Year						
African producer	0	0	0	0	0	0
Australian producer	0	0	0	0	0	0
Canadian producer	400	15	1	200	22	1
US producer	1,291	49	8	302	33	2
Other seller	950	36	2	415	45	1
	2,641	100	11	917	100	4
1982 Transaction Year						
African producer	0	0	0	0	0	0
Australian producer	0	0	0	0	0	0
Canadian producer	150	7	1	0	0	0
US producer	440	21	4	0	0	0
Other seller	1,538	72	8	2,100	100	4
	2,128	100	13	2,100	100	4
1983 Transaction Year						
African producer	0	0	0	0	0	0
Australian producer	0	0	0	0	0	0
Canadian producer	710	20	2	200	5	1
US producer	1,325	37	9	0	0	0
Other seller	1,557	43	5	3,747	95	8
	3,592	100	16	3,947	100	9
1984 Transaction Year (first seven months)						
African producer	0	0	0	0	0	0
Australian producer	0	0	0	0	0	0
Canadian producer	1,350	28	3	1,034	28	2
US producer	622	13	4	474	13	2
Other seller	2,833	59	5	2,134	59	5
	4,805	100	12	3,642	100	9

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[1] Includes purchases by utility fuel procurement departments only. Excludes purchases by national companies which may sell uranium to utilities.
[2] Refers to deliveries within one year, and in some cases deliveries within two years if pricing terms are known.
[3] Transaction year includes transactions listed in the February Report of the referenced year through the January Report of the following year.
[4] Other sellers include utilities, fuel procurement organizations independent of utilities, trading companies, and other organizations not defined as producers. The material they sell may be of any origin.

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of the market has declined, while that of other sellers and Canadian producers has increased.

No sales by Australian producers have been reported during the last six years, mainly because the government-imposed floor price has exceeded the market price for most of the referenced period. African producers generally have not sold in the nearer-term market primarily because prices have been so low, and the producers have been reluctant to set a precedent that might be used to their detriment in annual price negotiations under their longer-term contracts.

In recent years, non-producer inventory sellers (other sellers) have gained the majority share of the nearer-term market in both the USA and Europe. Much of the natural uranium that has been sold by other sellers has been liberated by deenrichment swaps and SWU assignments in the secondary market for enrichment services. In a few notable cases, US utilities have liquidated their uranium holdings at bargain prices following the cancellation of their nuclear power units.

During the past year, non-US inventory holders have been willing to sell material at low dollar prices in large part because of the strength of the US dollar against other currencies. Favorable exchange rates have also drawn some non-US producers into the nearer-term market. However, in the case of some Canadian producers that have become active in both the longer-term market and the nearer-term market, the increase in activity can best be attributed to the high grade of the deposits they mine.

Conclusion

The uranium purchasing practices of US and European utilities during the early 1980s changed in accordance with three basic trends.

1. The amount of unfilled requirements dropped steadily due to coverage under existing longer-term contracts, as well as to sharp reductions in planned nuclear generating capacity.
2. Canadian producers received most of the recent longer-term business in Europe, and a large amount in the USA. Producers in Western Canada owning large, high-grade deposits, have offered low prices for their uranium.
3. Non-producer inventory holders liquidated much of their unneeded stocks in the nearer-term market. Plant delays and cancellations created many of the excessive inventories, while an active secondary market for enrichment services liberated much of the natural uranium. A strong US dollar has created currency exchange rates favorable to non-US sellers, and has had a deflationary effect on uranium prices.

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JAPAN

Report 191 (July 1984) outlined an FEPC (Federation of Electric Power Companies) plan for siting commercial enrichment, reprocessing, and low-level waste facilities. The plan recommended location of all facilities at one or two sites on the Shimokita Peninsula at the extreme north end of Japan's main island of Honshu.

Subsequent discussion by FEPC representatives with local officials and citizens' groups of Aomori Prefecture has resulted in the selection of a single site for the entire complex. The site covers 6.5 square kilometers near the municipality of Rokkasho-Mura, in the Mutsu-Ogawara industrial development area on the Pacific side of Aomori Prefecture.

The FEPC has modified and formalized some of the details surrounding the complex, including facility capacities and scheduled operation dates.

1. *Enrichment:* A new company will be formed by the utilities to own and operate a plant capable of producing 150,000 SWUs per year by 1991, and 1.5 million SWUs by 1997. The FEPC estimates that the plant will require an investment equivalent to approximately $600 million. Power Reactor and Nuclear Fuel Development Corporation (PNC) has developed centrifuge technology for use at the plant (see Report 189). Facilities will be expanded incrementally.

2. *Reprocessing:* The Japanese utilities organized Japan Nuclear Fuel Services (JNFS) in 1980 to oversee the construction and operation of the commercial-scale reprocessing plant. The plant will consist of a 3,000-ton spent fuel storage facility, to be in operation in 1991, adjacent to a reprocessing facility having the capacity to process 800 tons of spent fuel per year by 1995. The 800-ton capacity target is a reduction from the previous proposal of 1,000 tons per year by the early 1990s. Technology will be adopted from PNC's 210-ton per year demonstration plant at Tokai-Mura. The estimated cost of the reprocessing plant will be close to $3 billion.

3. *Low-level Waste Storage:* The FEPC will form a new company to handle the transport and storage of low-level waste generated by the country's LWRs. At the present time no central storage facility exists in Japan; each plant has its own on-site waste-storage facility. By 1991 the national facility will have the capacity to store approximately 1 million 55-gallon drums. The utilities visualize subsequent expansion to contain the equivalent of 3 million drums. The expected cost of the facility is approximately $400 million.

The FEPC has initiated negotiations on a local level to acquire the approvals necessary for construction of the planned complex, and hopes to begin site preparation within one to two years. Because the site is located in an area designated by the national government for industrial development, much of the non-nuclear review process has been completed. Under favorable licensing conditions, the planned commercial operation dates may be achieved.

In a related development, the three manufacturers that supply centrifuges to PNC for its enrichment program announced plans to form a joint venture to provide machines to the new enrichment company. Toshiba, Hitachi, and Mitsubishi Heavy Industries (MHI) are scheduled to organize a company later this year. The company would be located in Sendai, the largest metropolitan area near the Rokkasho site. In August, the three conglomerates opened a joint office for initial organizational work.

SOUTH AFRICA

NUCOR (the Nuclear Development Corporation of South Africa [Pty] Ltd.) recently released an updated official assessment of South Africa's uranium resources and production capabilities. Although the release of such information is closely controlled in South Africa under the National Energy Act, the report contains some of the most comprehensive information published on the subject. Included are the latest official assessments of trends in uranium prospecting, production and prices, as well as discussions of geology and national policy matters.

NUCOR periodically reassesses South Africa's uranium resource and production capabilities. It expresses the total recoverable resources and their associated costs in terms of Reasonably Assured Resources (RAR) and Estimated Additional Resources (EAR). RAR refers to uranium that occurs in deposits known to facilitate recovery within given production cost ranges using current technology. Category I of EAR refers to uranium that is expected to occur in extensions of known deposits, but where specific data to classify the resource as RAR is inadequate.

Table 5 summarizes the NUCOR findings during 1983. NUCOR estimated that the total RAR and EAR recoverable for less than $130 per kgU ($50 per pound U_3O_8) amounted to 460,000 MTU (1.196 billion pounds U_3O_8). That figure represents a 13.4 percent decline compared to the 1981 assessment. South Africa produced 6,060 MTU (15.75 million pounds U_3O_8) in 1983, surpassing 1981 production by 244 tons, or 4.2 percent.

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RECENT DEVELOPMENTS

South Africa reinforced its position as a leader in uranium production by supplying 14 percent of the free world's uranium in 1983. By current estimates, the country also holds 14 percent of the free world's uranium resources, so its supply position appears secure. The Witwatersrand quartz-pebble conglomerates are the basis of 97 percent of South Africa's production; the Palabora project produces the remaining 3 percent as a by-product of copper mining. Exploration in the Witwatersrand and the discovery of potentially viable deposits in the Karoo Sequence have rendered uncertain the forecasts of long-term uranium production in South Africa. However, it is clear that the country will continue to be a major world producer well into the next century.

Table 5

SOUTH AFRICA'S URANIUM RESOURCES IN THE RAR AND EAR-1 CATEGORIES[1] AS OF JANUARY 1, 1983, AND JANUARY 1, 1981[2]

(Expressed in metric tons U)

Principal Deposits or Districts	Reasonably Assured Resources (RAR)[3]		Estimated Additional Resources (EAR)[4]		Percent of Total
	$0-$80/kgU	$80-$130/kgU	$0-$80/kgU	$80-$130/kgU	
Witwatersrand Basin Conglomerates	163,000 (206,000)	50,000 (55,000)	98,000 (81,000)	43,000 (80,000)	77 (79)
Witwatersrand Basin Tailings	22,000 (35,000)	21,000 (9,000)	— (2,000)	— (5,000)	9 (9)
Palabora	2,000 (3,000)	— —	— —	— —	1 (1)
Karoo Sequence	4,000 (3,000)	50,000 (44,000)	1,000 (1,000)	5,000 (6,000)	12 (10)
Younger Surficial Sediments	— —	1,000 (1,000)	— —	— —	1 (1)
TOTAL RESOURCES	191,000 (247,000)	122,000 (109,000)	99,000 (84,000)	48,000 (91,000)	100 (100)

[1] Exploitable at costs of less than $130/kgU.

[2] Estimates as of January 1, 1981 are shown in parentheses.

[3] Reasonably Assured Resources (RAR) refers to uranium that occurs in known mineral deposits of such size, grade and configuration that it could be recovered within the given production cost ranges with currently proven mining and processing technology. Estimates of tonnage and grade are based on specific sample data and measurements of the deposits and on knowledge of deposit characteristics. Reasonably Assured Resources have a high assurance of existence and in the cost category below $80/KgU are considered as *reserves* for the purposes of this table.

[4] Estimated Additional Resources category 1 (EAR-1) refers to uranium in addition to RAR that is expected to occur, mostly on the basis of direct geological evidence in extensions of well-explored deposits and in deposits in which geological continuity has been established but where specific data and measurements of the deposits and knowledge of the deposits' characteristics are considered to be inadequate to classify the resource as RAR. Such deposits can be delineated and the uranium subsequently recovered, all within the given cost ranges. Estimates of tonnage and grade are based on such sampling as is available and on knowledge of the deposit characteristics as determined in the best-known parts of the deposit or in similar deposits. Less reliance can be placed on the estimates in this category than on those for RAR.

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UNITED KINGDOM

The Central Electricity Generating Board (CEGB) has begun commercial operation of three AGRs (Advanced Gas-cooled Reactors) thus far in 1984, and by year-end three more units are scheduled to achieve that status (Table 6). Thus, 1984 is a milestone year in the implementation of the UK's long-delayed commercial AGR program. Construction is proceeding rapidly on two other AGRs, Heysham Units B1 and B2; CEGB expects to begin commercial operation of those in 1987 and 1988. The South of Scotland Electricity Board (SSEB) is building two AGRs at Torness Point in northern Scotland; construction there is proceeding smoothly also.

Nuclear power's contribution to CEGB's electricity generation has doubled since last year, partly because of the completion of the new units, but mostly because of the six-month-old national coal strike. The coal strike has forced CEGB also to increase the use of oil, which has had the effect of raising the utility's operating costs substantially.

In recent months, the Sizewell inquiry, which began twenty months ago, has focused on the merits of the PWR design compared to the AGR. Recent progress with the AGR may actually be hurting CEGB's case for Sizewell. The Sizewell B PWR plan arose largely in response to the limitations and bad luck of the AGR program during the 1970s. As CEGB, SSEB, and the associated industrial groups have gained experience and the AGR program has matured, questions have arisen about the wisdom of abandoning the design, which was developed in the UK. However, because CEGB has invested heavily in the PWR's future, it is unlikely the utility will reverse its design decision.

Table 6

ADVANCED GAS-COOLED REACTORS IN THE UK

Unit	Net MWe	Utility	Percent Complete	COD[1]
Hinkley Point B1	625	CEGB[2]	100	Jun 1976
Hinkley Point B2	625	CEGB	100	Jan 1977
Hunterston B1	625	SSEB[3]	100	Jun 1976
Hunterston B2	625	SSEB	100	May 1977
Dungeness B1	600	CEGB	100	Mar 1984
Heysham A1	625	CEGB	100	May 1984
Hartlepool A1	625	CEGB	100	May 1984
Heysham A2	625	CEGB	100	1984
Hartlepool A2	625	CEGB	100	1984
Dungeness B2	600	CEGB	100	1984
Heysham B1	660	CEGB	60	1987
Heysham B2	660	CEGB	45	1988
Torness Point 1	660	SSEB	50	1987
Torness Point 2	660	SSEB	34	1988

[1] COD = Commercial Operation Date, based on published information and utility forecasts.

[2] CEGB = Central Electricity Generating Board.

[3] SSEB = South of Scotland Electricity Board.

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UNITED STATES

Introduction

Four nuclear power units have begun commercial operation in the USA in the past eight months, adding 4,258 MWe to US nuclear generating capacity and increasing the US total by approximately three percent. Another four utilities earned full power operating licenses, and two of them are planning to bring their reactors to commercial operation before the end of the year (Table 7). If the utilities succeed in their plans, twice as many units will have begun commercial generation this year as in 1983. While such a development might encourage an optimistic outlook for the future of nuclear power in the USA, utilities unfortunately will end the year facing the same financial, institutional, and societal obstacles that have plagued the industry for years. Moreover, utilities still must face reduced projections of electricity demand, which have contributed heavily to the numerous delays and cancellations of nuclear plants.

Commercial Operations

Southern California Edison's San Onofre Unit 3 on April 1, 1984 became the latest reactor to begin commercial operation. South Carolina Electric and Gas Company's Summer Unit 1 and Duke Power's McGuire Unit 2 began commercial operations in January and March, respectively. Commonwealth Edison added its La Salle Unit 2 to the rate base in August, after receiving a full power license in April 1984; the unit probably will enter commercial operation by the end of this year.

Diablo Canyon

Years of litigation and plant modifications at Pacific Gas & Electric's (PG&E) Diablo Canyon Unit 1 culminated in August with an NRC decision to grant the utility a full power operating license. PG&E received a construction permit for Diablo Canyon Unit 1 in April 1968, and PG&E's application for an operating license had been

Table 7

1984 NUCLEAR POWER LICENSING PROGRAMS IN THE USA

Unit	Utility	Date	Type	MWe net
Commercial Operation				
Summer 1	South Carolina Electric & Gas	Jan 1984	PWR	900
McGuire 2	Duke Power	Mar 1984	PWR	1180
San Onofre 3	Southern California Edison	Apr 1984	PWR	1100
La Salle 2	Commonwealth Edison	Aug 1984	BWR	1078
Full Power Operating Licenses				
WNP 2	Washington Public Power	Apr 1984	BWR	1100
Susquehanna 2	Pennsylvania Power and Light	Apr 1984	BWR	1050
Grand Gulf 1	Mississippi Power and Light	Jul 1984	BWR	1250
Diablo Canyon 1[1]	Pacific Gas & Electric	Aug 1984	PWR	1084
Fuel Loading and Low Power Testing Licenses				
Callaway 1	Union Electric	Jun 1984	PWR	1150
Catawba 1[2]	Duke Power	Jul 1984	PWR	1145
TOTAL MWe				10,137

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[1] The full power license for Diablo Canyon 1 has been rendered ineffective by a federal appeals court's injunction designed to block full power operation. The case is awaiting further federal hearings.

[2] The NRC authorized fuel loading and pre-critical testing for Duke Power's Catawba Unit 1, but it has not yet granted the utility a low power license.

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pending since 1973, making it the NRC's longest-running case. The utility received a low power operating license in September 1981, but the NRC suspended the license in November 1981 due to lack of adequate seismic safety assurances. The full power license was granted on August 2, 1984, and PG&E was prepared to initiate full power testing following the activation of the order by the NRC legal department. When PG&E received the license, opponents of the project quickly renewed objections based on the plant's proximity to an earthquake fault, and a federal appeals court issued an injunction that temporarily blocked power testing. Supreme Court Justice Warren Burger upheld the injunction, possibly so the entire Supreme Court could review the case, by refusing to hear a PG&E appeal. The current review of the case by federal appeals courts may delay full power testing for an indefinite period.

An NRC licensing decision for low power testing regarding Diablo Canyon Unit 2 depends on the outcome of an independent design verification program now taking place. The unit is 97-percent complete, and PG&E plans to begin commercial operation in June 1985.

Full Power Operating Licenses

Several other units reached full power operation in the first half of 1984. Following numerous management changes at Mississippi Power and Light, the NRC granted the utility a full power license for its Grand Gulf Unit 1 in August, and the utility has begun power ascension. In reviewing the case, the NRC noted the plant's history of design problems and technical specification errors, and commended the utility's efforts to alleviate those problems. The utility does not expect commercial operation for another seven months. Mississippi Power and Light plans to resume construction on Grand Gulf Unit 2, which is 30-percent complete, after Unit 1 begins commercial operation.

In May, Pennsylvania Power and Light (PP&L) received a full power license for its Susquehanna Unit 2. The utility plans to begin commercial operation at the end of this year. PP&L purchased the initial fuel core for Cincinnati Gas & Electric Company's Zimmer plant for reload use in Susquehanna Unit 2. The unused core, which had been on the Zimmer site since 1979, required refabrication because the Zimmer fuel was not as highly enriched as the fuel used by the Susquehanna unit. Once refabricated, the core should provide about one-third of the material for five to six reloads.

Fuel Loading and Low Power Testing

One utility received approval for fuel loading in 1984, and one received authorization for low power testing. The NRC approved pre-criticality testing for Duke Power Company's Catawba Unit 1 in July 1984, and the utility is expected to seek NRC approval for full power operations near the end of 1984. Still to be resolved before the unit can be licensed are some quality assurance and welding problems related to the plant's safety systems. However, those issues probably will not delay the scheduling of full power license requests.

Fuel loading began at Union Electric Company's Callaway Unit 1 in June, and the low power license granted by the NRC allowed the unit to begin 5-percent power operation. Union Electric was about six months ahead of the NRC's projected schedule for receiving the low power license, and the utility is anticipating a request for a full power license by September 1984. Union Electric has submitted a rate increase request to the Missouri Public Service Commission to help defray the cost of the Callaway plant. It is seeking either a single 65-percent ($639 million) rate increase, or a $708 million increase spread over a five-year period, with a 25-percent increase the first year and 8-percent increases over each of the four succeeding years. The utility estimates that the construction of the Callaway plant is responsible for 85 percent of the proposed rate hike.

Setbacks

Several utilities canceled plans for new units in the first eight months of 1984. The most recent was the TVA (Tennessee Valley Authority) cancellation of four of its units on August 29, 1984. This action had been expected since the utility decided to mothball Hartsville Units A-1 and A-2 and Yellow Creek Units 1 and 2 in 1982. The TVA action had no effect on Nuexco forecasts of uranium consumption, because the forecasts have for several years anticipated the cancellations. TVA estimated that $5 billion would be required to finish the Hartsville plant, which is 44-percent and 34-percent complete. The Yellow Creek plant, which is 35-percent and 3-percent complete, would require another $9.6 billion. TVA hopes to sell plant hardware that has already been purchased.

Consumers Power Company "shut down" its two-unit Midland plant on July 16. The utility has filed to recover the $3.6 billion in construction costs and $400 million in fuel costs invested as of August, and has turned to the Michigan Public Service Commission for financial relief. Consumers Power is threatening to file for bankruptcy unless enough sunk costs are recovered. The units, both about 85-percent complete, originally were scheduled for completion in 1978 and 1979. The utility is considering mothballing the plant in the hopes that its completion someday will become economically feasible. However, the costs of mothballing, estimated to be about $85 million, plus annual maintenance costs exceeding $15 million, may be prohibitive.

Consumers Power also must decide what to do with the two fabricated initial fuel cores purchased for the Midland units. The cores reportedly contain a total of 164,000 kgU in enriched UF_6. While Consumers could refabricate the material for use in one of the other units, it may consider offering the cores for sale. However, it is likely that the utility will hold on to the cores for the remainder of the year.

Public Service of Indiana effectively canceled its Marble Hill Units 1 and 2 in January 1984 when it withdrew financial support for the plant. Shortly thereafter, Cincinnati Gas and Electric announced the cancellation of its Zimmer nuclear plant. The Zimmer plant may be converted to a coal-fired station, although the cost of such a conversion would approach the cost of finishing the nuclear plant. (These developments were reported in Report 188, in an article summarizing the US nuclear plant backlog for 1984).

Conclusion

While projected commercial operation dates seem to indicate an upward trend in the industry, it is too early to draw optimistic conclusions for 1984. It is possible that there will be a substantial increase in the number of commercially operating units compared to 1983. Several projects have made extraordinarily good progress of late, such as Union Electric's Callaway Unit 1, which is six months ahead of schedule. Conversely, plants with long histories of licensing or management problems, such as Diablo Canyon Unit 1, continue to encounter public resistance. Among other problems, the financial burden associated with the construction of a nuclear plant still severely restricts utilities. When a plant such as Midland is canceled after reaching 85-percent completion, utilities understandably are discouraged from taking risks associated with building new units. In fact, it is virtually certain that no new orders for nuclear power units will be placed in the USA in this decade, and perhaps not in this century.

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KOREA

Nuclear Power Program

Twenty years of rapid growth in the Korean economy led to an ambitious nuclear power plan in the mid-1970s for 30,000 MWe of nuclear generating capacity by 1990. Slower economic growth in recent years has led Korea Electric Power Company (Kepco) to reduce that target to 7,165 MWe. Three units are currently operating commercially; they generated approximately 5.7 million megawatt-hours (MWh) of electricity in the first half of 1984. Two of the three operating units are Westinghouse PWRs located at the Ko-Ri site near Pusan; the third operating unit is a 629-MWe Candu that was built and tested in under six years. Six units are currently under construction (Table 8), while construction generally has proceeded briskly. Kepco has had some technical and contractual problems with the two Framatome units at Ul-Jin.

Kepco is responsible for all generation and distribution of electricity in South Korea. Its nuclear power development program is outlined in the government's five-year plans. Kepco rescheduled the nuclear program most recently in November 1983, postponing plans for new units and delaying the completion dates of the six units under construction. Three factors explain the cutbacks in the utility's plans:

1. The slowdown of economic growth in recent years and the consequent decline in electricity demand growth;
2. The drop in oil prices, which has made less urgent the need to cut dependence on oil (55 percent of generating capacity in 1981);
3. The government's desire to reduce the foreign debt ($40.2 billion as of January 1984).

Other Developments

While the nuclear power program in general has slowed, South Korea is proceeding with other developments. The country seeks to increase the degree of autonomy and self-sufficiency in its nuclear program. All three operating units were built on a turnkey basis, but the newer units have involved a degree of Korean participation. The Korea Power Engineering Corporation (Kopec), an engineering subsidiary of Kepco, is promoting the development of local architect-engineering capability through joint ventures and agreements with overseas companies. The firm is aiming for 21 percent of the architect-engineering work on Ko-Ri Units 5 and 6.

Kepco also manages and partially owns Korea Heavy Industries and Construction (KHIC), and is helping KHIC to localize the construction of all major hardware components by the end of the 1980s. KHIC is involved in most of the work on the Framatome units now under construction, and, as the sole designated Korean manufacturer, it is the umbrella licensee to the main supplier companies abroad. KHIC hopes to award subcontracts in the future to smaller Korean companies.

South Korea also plans to build a fuel fabrication plant, to be operational by 1990, sufficient for Kepco's planned program. Fifty-one percent of the 200 MTU per year plant will be controlled by Kepco and the Korea Advanced Energy Research Institute (KAERI), a department within the Ministry of Science and Technology. Foreign interests will control the remaining 49 percent.

Table 8

NUCLEAR POWER UNITS IN SOUTH KOREA

Unit	Plant	MWe	Type	COD[1]	Percent Complete
KNU 1	(Ko-Ri)	556	PWR	4/78	100
KNU 3	(Wolsung)	629	Candu	4/83	100
KNU 2	(Ko-Ri)	605	PWR	7/83	100
KNU 5	(Ko-Ri)	895	PWR	3/85	90
KNU 6	(Ko-Ri)	895	PWR	12/85	80
KNU 7	(Yeonggwang)	900	PWR	3/86	60
KNU 8	(Yeonggwang)	895	PWR	3/87	50
KNU 9	(Ul-Jin)	895	PWR	3/88	25
KNU 10	(Ul-Jin)	895	PWR	3/89	20

[1] Actual or expected Commercial Operation Date.

Fuel Sources

South Korea (population 40 million) relies heavily on uranium imports, although it has approximately 43.6 million tonnes of black shale uranium resources with an average grade of 0.04 percent. The Korea Institute of Energy and Resources has developed the technology for recovery of the uranium. In addition, KAERI is building a pilot plant capable of processing three tonnes of ore per day. Canadian and Australian producers each supply approximately 40 percent of South Korea's natural uranium requirements; Cogema provides the balance, which will be used for the two Framatome units at Ul-Jin (Figure 6).

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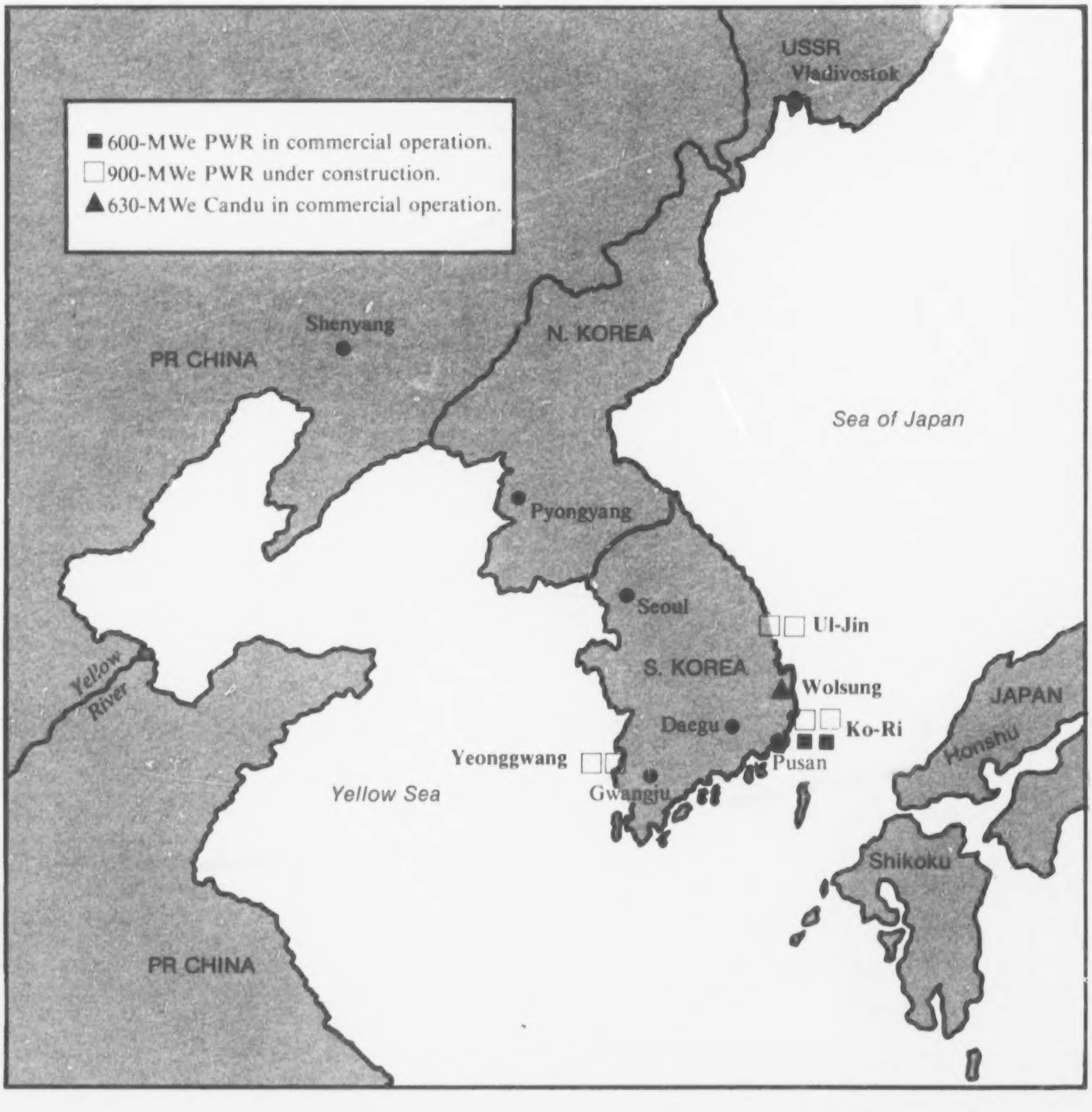
Figure 6

NUCLEAR POWER UNITS IN SOUTH KOREA


■ 600-MWe PWR in commercial operation.
☐ 900-MWe PWR under construction.
▲ 630-MWe Candu in commercial operation.
USSR
Vladivostok
Shenyang
PR CHINA
N. KOREA
Sea of Japan
Pyongyang
Seoul
Ul-Jin
S. KOREA
Wolsung
Ko-Ri
Daegu
Pusan
Yeonggwang
Gwangju
Yellow River
Yellow Sea
JAPAN
Honshu
Shikoku
PR CHINA

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Kepco has also acquired interests in mining ventures abroad. It owns 4.5 percent of the Dawn Lake project in Canada, development of which may begin in the 1990s. It also established a joint venture with Taiwan Power Company and the Anschutz Corporation of the USA to explore for uranium in Paraguay, but the effort was recently terminated. Kepco is exploring for uranium in Gabon in cooperation with Cogema and the government of Gabon.

Kepco's enrichment needs are covered by Adjustable Fixed-Commitment contracts with DOE, except for the two Framatome units, which are covered by Cogema. Kepco has expressed interest in converting to the Utility Services enrichment contract (USEC).

TAIWAN

Nuclear Power Program

Taiwan's five commercially operating nuclear power units generated approximately 10.1 million megawatt-hours (MWh) in the first half of 1984. Two of the units, Chin-Shan 2 and Kuosheng 1, have operated above 80-percent capacity factors this year. The 907-MWe Maanshan Unit 1 began commercial generation on July 27, 1984. Maanshan Unit 2 is 90-percent complete and is scheduled to begin commercial operation in May 1985 (Table 9).

Table 9

NUCLEAR POWER UNITS IN TAIWAN

Unit	MWe	Type	COD[1]	Percent Complete
Chin-Shan 1	604	BWR	Dec 1978	100
Chin-Shan 2	604	BWR	Sep 1979	100
Kuosheng 1	951	BWR	Dec 1981	100
Kuosheng 2	951	BWR	Mar 1983	100
Maanshan 1	907	PWR	Jul 1984	100
Maanshan 2	907	PWR	May 1985	90

[1] Actual or expected Commercial Operation Date.

There are three existing plant sites in Taiwan (Figure 7), each of which can accommodate more units. Recently, however, Taipower (Taiwan Power Company) revived plans to build two units at a new plant site, Yenliao. The state utility has budgeted $4.3 billion for the new plant, which it hopes to have in operation in the early 1990s. A 10.9-percent increase in electricity consumption last year, coupled with an expected 1984 real economic growth rate of 8 percent, induced Taipower to revive the seventh and eighth units. The utility is likely to invite bids in the near future from General Electric, Westinghouse, Combustion Engineering, Framatome and Kraftwerk Union; Taipower itself probably will serve as constructor.

Unlike the situation in Korea and Japan, the desire to develop complete domestic nuclear engineering capability has not been pronounced in Taiwan. All of the operating reactors and most of the nuclear technology have come from the USA. However, Taipower has a strong construction division and generally works closely with US architect-engineering firms, notably Ebasco and Bechtel. All of the civil engineering responsibilities are handled by local companies.

Fuel Supplies

Taipower currently has an inventory of uranium amounting to several years' forward consumption. African producers provide over 70 percent of needs through 1989, while Australian and US producers supply the remainder. Conversion is handled in the USA by Allied. Geologists recently made the first indigenous discovery of uranium in Taiwan at Sanhsia, 20 kilometers south of Taipei, following almost a year of exploration. Drill holes indicated ore grade of 0.36 percent.

Enrichment services for all six existing units are contracted to DOE under AFCs, and it is likely the utility will convert soon to the USEC. Taipower has purchased some SWUs by assignment from US utilities.

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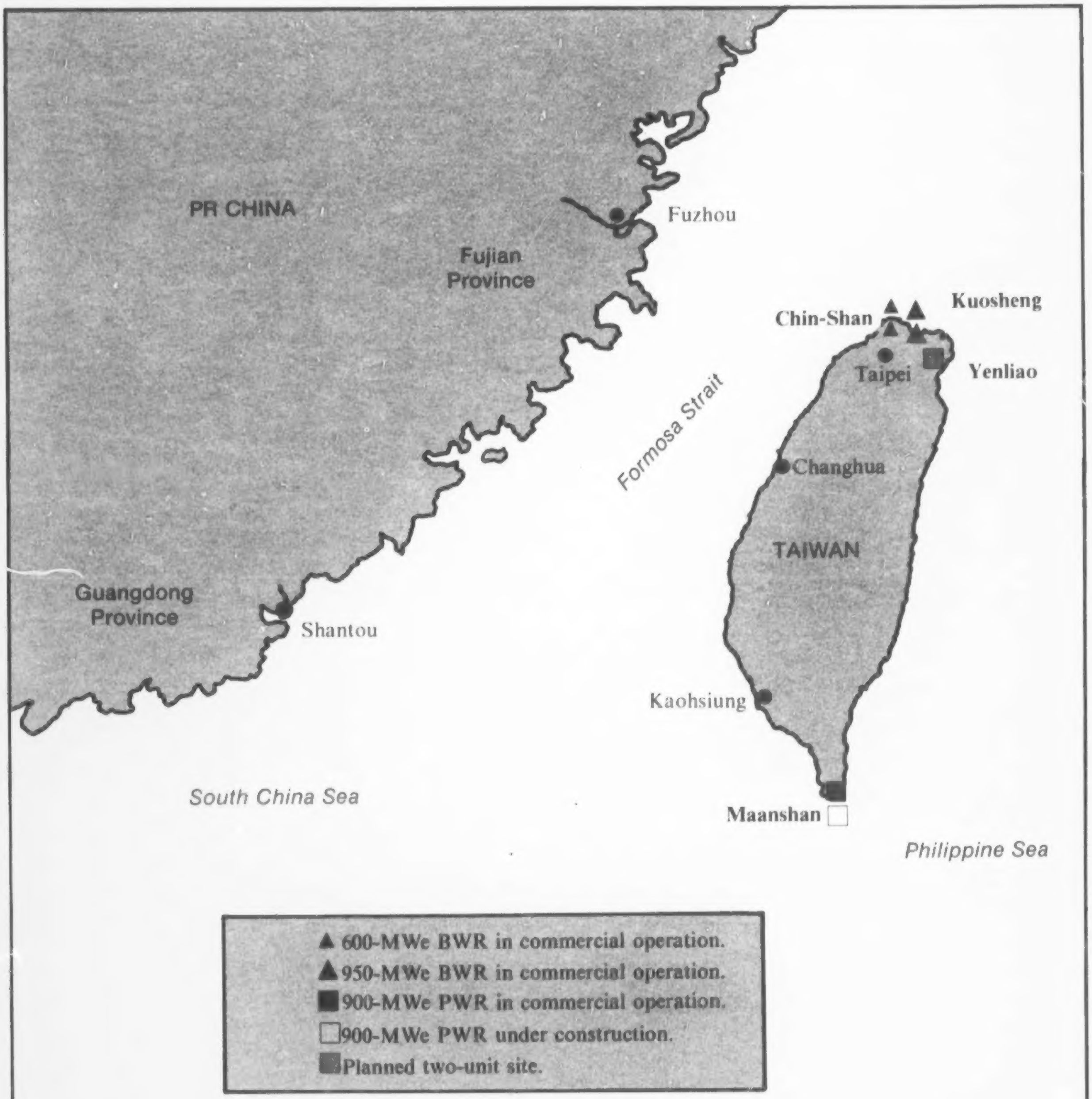
PR CHINA
Fujian Province
Fuzhou
Guangdong Province
Shantou
Formosa Strait
South China Sea
Philippine Sea
Chin-Shan
Kuosheng
Taipei
Yenliao
Changhua
TAIWAN
Kaohsiung
Maanshan
▲ 600-MWe BWR in commercial operation.
▲ 950-MWe BWR in commercial operation.
■ 900-MWe PWR in commercial operation.
☐ 900-MWe PWR under construction.
▨ Planned two-unit site.

Figure 7

NUCLEAR POWER UNITS IN TAIWAN

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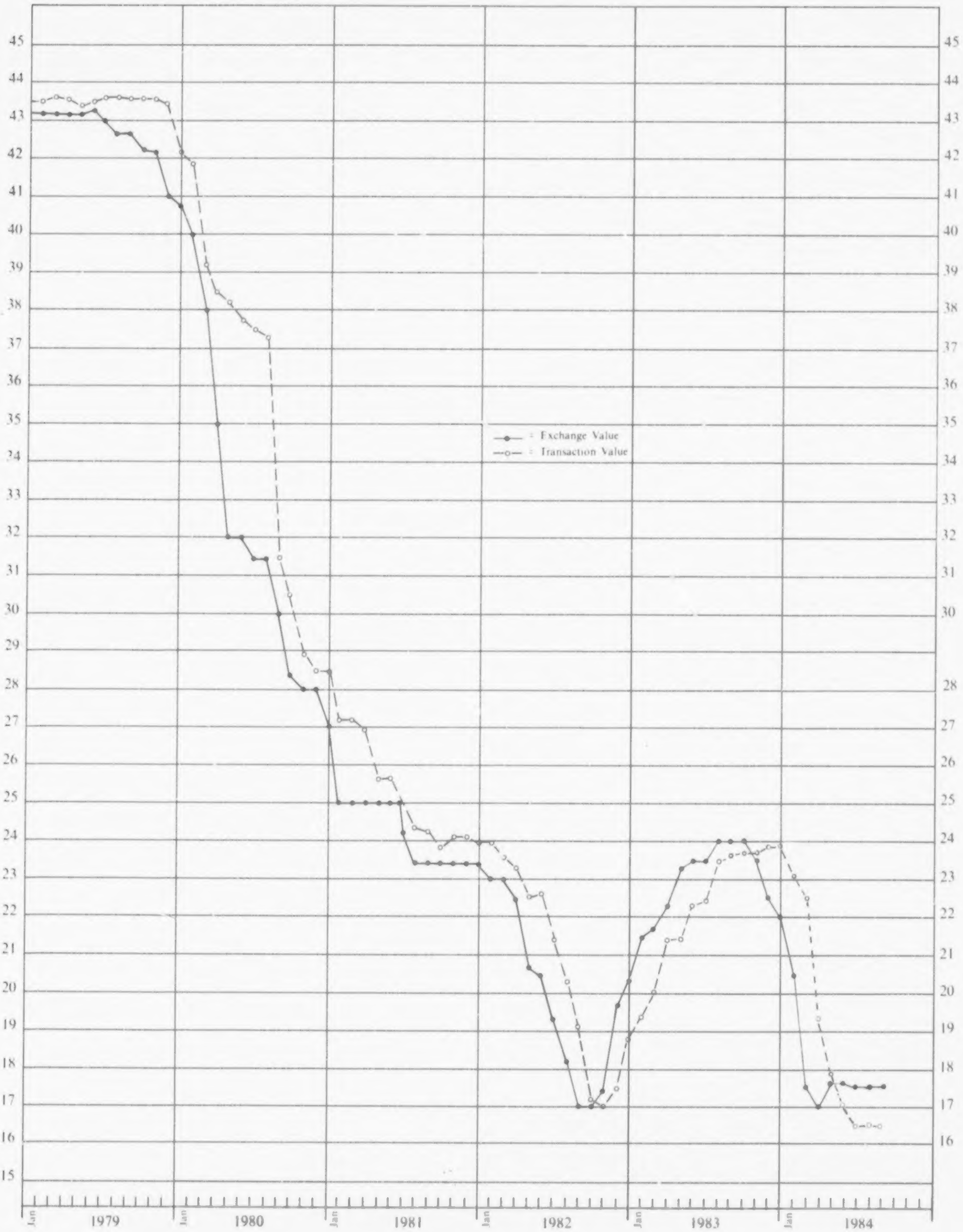
HISTORICAL MARKET DATA

EXCHANGE AND TRANSACTION VALUES SINCE JANUARY 1979

Determined as of the last day of the month indicated



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HISTORICAL MARKET DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	32.50	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00
1984	20.50	17.50	17.00	17.75	17.75	17.50	17.50	**17.50**				

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85
1984	23.05	22.50	19.25	17.90	17.00	16.50	16.60	**16.40**				

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60
1984	0.60	0.30	0.80	0.80	0.80	0.00	0.00	**0.80**				

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AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage Earners, Weekly Rates[2] (1976=100)
1983 Avg.	401.2	181.8
April 1983	407.3	180.9
May 1983	414.7	180.9
Jun 1983	415.6	181.0
Jul 1983	408.3	180.7
Aug 1983	403.0	180.7
Sep 1983	402.9	180.6
Oct 1983	397.5	188.3
Nov 1983	395.5	188.3
Dec 1983	399.2	188.1
Jan 1984	399.1	188.3
Feb 1984	402.4R	188.2
Mar 1984	403.8	188.0
Apr 1984	404.1R	195.6
May 1984	403.8R	196.4R
Jun 1984	404.8P	

CANADA

	Industry Selling Price Index: Manufacturing[1] (1971=100)	Wage-earner Data: Average Hourly Earnings (C$)[2]					
		Uranium Mines (SIC 057)	Metal Mines (SIC 051-059)	Mines, Quarries and Oil Wells[3] (SIC 051-099)	Primary Metal Industries Non-ferrous[4]		Chemicals and Chemical Products[5] (SIC 372-379)
					(SIC 296)	(SIC 298)	
1983 Avg.	298.8	—	14.69	14.30	—	—	11.17
Jul 1983	300.4	16.48	14.35	13.93	11.70	9.83	11.04
Aug 1983	301.3	16.93	14.36	13.89	11.82	10.08	11.19
Sep 1983	301.1	17.66	14.90	14.41	11.99	10.32	11.29
Oct 1983	301.6	17.73	15.27	14.65	11.76	10.03	11.30
Nov 1983	301.8	17.82	15.29	14.67	11.78	10.62	11.38
Dec 1983	302.9	17.84	15.11	14.66	11.86	10.60	11.51
Jan 1984	305.4	17.74	15.27	14.74	11.91	10.84	11.69
Feb 1984	306.6	17.78	15.59	14.90	12.04	10.82	11.51
Mar 1984	308.7R	18.05	15.52	14.82	12.14	10.84	11.58
Apr 1984	310.4	18.06	15.83	15.10	11.96	10.34	11.63
May 1984	310.5	18.48P	15.64R	15.06R	12.11R	10.16R	11.65R
Jun 1984	310.8R	16.35P	15.09P	14.61P	12.27P	10.27P	11.67P
Jul 1984	312.3P	—	—	—	—	—	—

P = Preliminary R = Revised since last month

For annual averages prior to 1983, and for notes pertaining to these statistics, see pages 23-26 of Report 190 of June 1984.

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GOVERNMENT STATISTICS

REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per per Metric Ton of Gold Ore Milled (Rand)[1]	Tonnage-Weighted Index of Average Working Costs per Metric Ton of Gold Ore Milled (March 1982=100)[2]	Consumer Price Index[3] (1975=100)[4]	Producer Price Index All Groups[5] (1975=100)	Total Employment in Mining and Quarrying (Code 35)[6]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[6]
1983 Avg.	51.87	115.0	262.2	274.8	696,579	3,644,772
Jul 1983	—	—	262.5	273.7	704,202	314,566
Aug 1983	—	—	265.6	278.9	698,984	311,789
Sep 1983	52.92	117.4	267.3	279.4	696,435	312,264
Oct 1983	—	—	270.0	281.0	693,225	311,418
Nov 1983	—	—	271.4	281.6	688,459	317,485
Dec 1983	53.70	119.6	273.2	283.7	690,750	333,595
Jan 1984	—	—	274.7	283.3	689,807	326,619
Feb 1984	—	—	278.4	286.5	702,553	335,906
Mar 1984	55.30	123.1	281.9	288.0	715,628	342,332
Apr 1984	—	—	286.1	290.2	712,963	327,550
May 1984	—	—	288.3	292.6	710,040	327,937
Jun 1984	56.95R	126.2	291.2	295.1	—	—
Jul 1984	—	—	295.1	—	—	—

UNITED STATES

	Producer Price Index[1]		Consumer Price Index[2]	GNP Implicit Price Deflator[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
	Industrial Commodities (1967=100)	All Commodities (1967=100)	(1967=100)	(1972=100)	Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1983 Avg.	315.8	303.1	298.4	215.63	12.57	13.43	10.59	8.65
Jun 1983	315.3	302.4	298.1	214.55	12.55	13.37	10.52	8.63
Jul 1983	316.5	303.2	299.3	—	12.59	13.56	10.59	8.67
Aug 1983	317.3	304.7	300.3	—	12.54	13.46	10.62	8.62
Sep 1983	317.1	305.3	301.8	216.44	12.62	13.46	10.70	8.73
Oct 1983	318.5	306.0	302.6	—	12.67	13.55	10.79	8.71
Nov 1983	318.3	305.5	303.1	—	12.64	13.56	10.86	8.77
Dec 1983	318.4	306.1	303.5	218.53	12.75	13.33	10.90	8.84
Jan 1984	319.1	308.0	305.2	—	12.67	13.38	10.91	8.88
Feb 1984	320.6	308.9	306.6	—	12.81	13.34	10.90	8.86
Mar 1984	321.9	311.0R	307.3	220.58	12.85	13.33	10.95	8.88
Apr 1984	322.5	311.4	308.8	—	12.98R	13.29R	10.97	8.89
May 1984	323.3	311.7	309.7	—	12.99R	13.37R	11.02R	8.89R
Jun 1984	323.9	311.4	310.7	222.33R	12.99P	13.41P	11.05R	8.91R
Jul 1984	324.0	312.0	311.7	—	—	—	11.14P	8.94P

P = Preliminary R = Revised since last month

For annual averages prior to 1983, and for notes pertaining to these statistics, see pages 23-26 of Report 190 of June 1984.

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NUEXCO

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EXECUTIVE SUMMARY
REPORT 193
(All data as of August 31, 1984)

Exchange Value **$17.50, unchanged**	The **Exchange Value** is **$17.50** per pound U_3O_8, unchanged since last month. Four recent uranium sales are reported, involving a total of 1.0 million pounds U_3O_8 equivalent. One was a sale of natural UF_6; all involved deliveries prior to 1986, but only one met the conditions for inclusion in the Transaction Value.
Supply-Demand Ratio **rose to 4.6:1**	Active spot and near-term **uranium supply** amounts to **5.1 million** pounds U_3O_8 equivalent, up 2.2 million pounds since last month. Active spot and near-term **uranium demand** totals **1.1 million** pounds, up approximately 200 thousand pounds. The spot and near-term **supply-demand ratio** rose to **4.6:1.**
Transaction Value **fell $0.20, to $16.40**	The **Transaction Value** is **$16.40** per pound U_3O_8, down $0.20 since last month. The calculation includes 10 transactions involving a total of 3.9 million pounds U_3O_8 and equivalent UF_6, and covers a period of 4 months.
Loan Use Charge Rate **unchanged at 6%**	The **Loan Use Charge Rate** remains **6 percent** per annum in an almost dormant market.
Conversion Value **rose to $0.80**	The **Conversion Value** is **$0.80** per pound U as UF_6, up from zero last month. No secondary market conversion transactions are reported. Active secondary market supply of conversion services for delivery within three years totals 2.8 million pounds U as UF_6. Active demand totals 845 thousand pounds U as UF_6.
SWU Values **$100 for DOE-origin (FY85)** **$85 for non-DOE origin** **(delivery within 15 months)**	The **SWU Values** are **$100** per SWU of DOE origin and FY85 delivery, up $5, and **$85** per SWU of non-DOE origin, unchanged since last month. Six SWU transactions are reported, involving approximately 700 thousand SWUs. Active secondary market SWU supply amounts to 215 thousand SWUs, while active demand totals 325 thousand SWUs.
Enrichment	It appears, as expected, that DOE will succeed in retaining almost all of its US and Japanese customers, while losing much of its market share in Europe.
Commentary	Speaking before a Congressional advisory panel, Nuexco Chairman J. R. Wolcott, citing the need for a clear definition of the role of the US government's uranium enrichment program in the international market, proposed the formation of an outside board of directors to oversee DOE activities.
Analysis & Commentary	Speaking at the Uranium Institute's Ninth Annual Symposium, Nuexco Vice-President Richard K. Andersen reported that secondary market sales of LEU inventories and DOE's offer of the USEC have combined to reduce U_3O_8 demand by 130 million pounds (1983-1991).
Analysis & Commentary	Reviews uranium purchases from 1979-1984 by US and European utilities.
South Africa	NUCOR recently released updated information on South Africa's uranium reserves.
United Kingdom	For the UK's long-delayed commercial AGR program, 1984 is a milestone year.
United States	Four nuclear power plants have begun commercial operation since the beginning of the year.
Annual Update	Both South Korea and Taiwan are continuing to add to their nuclear power programs.

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NUEXCO REPORT 193 FIGURES OF THE MONTH (August 31, 1984)	This Month (Report 193)	Last Month (Report 192)	12 Months Ago (Report 181)
Exchange Value[1]	17.50	17.50	24.00
Transaction Value[1]	16.40	16.60	23.60
Loan Use Charge Rate[2]	6%	6%	6%
Conversion Value[3]	0.80	0.00	1.10
Near-Term Uranium Supply[4]	5.1	2.9	6.7
Near-Term Uranium Demand[5]	1.1	0.9	2.4
Near-Term Supply-Demand Ratio	4.6	3.1	2.9
Recent Uranium Sales:			
Number of Transactions[6]	4	6	9
Quantity of Material[7]	1.0	1.3	1.8-3.9
Nuexco SWU Values:[8]			
DOE origin, FY85 delivery	100	95	—
non-DOE origin, delivery within 15 months	85	85	—
USDOE SWU Prices:			
USEC	135.00	135.00	—
AFC	153.00[9]	153.00[9]	138.65
Requirements	157.00[9]	157.00[9]	149.85
Market Value of Enriched UF_6[10] [11]:			
2.5 w/o U_{235}	537	513	598
3.0 w/o U_{235}	691	660	764
3.5 w/o U_{235}	848	810	933
4.0 w/o U_{235}	1,008	962	1,104

---

[1] US $ per pound U_3O_8 equivalent.

[2] Per annum.

[3] US $ per pound U as UF_6.

[4] Active inquiries to sell, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[5] Active inquiries to purchase, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[6] Uranium sales only; does not include loans, conversion, or SWU transactions.

[7] Millions of pounds U_3O_8, equivalent.

[8] US $ per SWU.

[9] Effective 10/1/84.

[10] Calculated using the Nuexco Exchange Value, Conversion Value, and 0.20 percent tails assay. From 2/28/83 through 9/30/83, calculations used the Nuexco SWU Value for the relevant fiscal year. From 10/31/83 through 2/29/84, calculations used the Nuexco SWU Value for DOE origin and FY84 delivery. As of 3/31/84, calculations use the Nuexco SWU Value for DOE origin and FY85 delivery.

[11] US $ per KgU as UF_6, rounded to the nearest $.

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OCTOBER 1984 **NUMBER 194**

MONTHLY REPORT

ON THE NUCLEAR FUEL MARKET

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MONTHLY REPORT ON THE NUCLEAR FUEL MARKET

October 1984 No. 194

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To Our Readers

Nuexco's mailing service made many errors in July and August. We apologize for any inconvenience the mistakes caused. Please contact any Nuexco office if you would like more copies. You can reach our Menlo Park office at (415) 854-1510; Telex: 470674 (NUEXCO UI).

* * *

Included with this Report is a copy of a speech entitled *Uranium Through the Looking Glass,* given by Mr. George White, Jr., President of Nuexco, at the Atomic Industrial Forum's Uranium Seminar in Keystone, Colorado on October 2.

* * *

Also included with this Report is a map to our headquarters in Menlo Park. We welcome customer visits.

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NATURAL URANIUM AND SECONDARY MARKET CONVERSION

The **Exchange Value** as of September 30, 1984 is **$17.50** per pound U_3O_8, unchanged since last month. The *Current Market Data* section of this Report lists four uranium sales transactions, involving a total of approximately 2,000,000 pounds U_3O_8 *equivalent*. One of those sales involved natural UF_6.

Active supply of natural uranium (U_3O_8 and UF_6) for spot or near-term delivery totals **5,490,000** pounds U_3O_8 or equivalent UF_6, up 435,000 pounds since last month. The corresponding figure for **active demand** is **955,000** pounds, down 95,000 pounds. The spot and near-term **supply-demand ratio** rose to **5.8:1.**

The **Transaction Value** as of September 30, 1984 is **$16.55** per pound U_3O_8, up $0.15 since last month. The current Transaction Value includes 12 transactions involving a total of 4.3 million pounds U_3O_8 or equivalent UF_6 and covers a period of 5 months. Two of the transactions reported this month involved deliveries before 1986, and also met the criteria for inclusion in the current Transaction Value calculation.

The **Loan Use Charge Rate** as of September 30, 1984 is **6 percent** per annum, unchanged since last month, in a nearly dormant market.

* * *

The Exchange Value is unchanged at $17.50; material is still available for sale at or below that level. The sale of small lots of U_3O_8 generally requires buyers to offer prices somewhat lower than $17.00 per pound U_3O_8. Sellers of larger lots of uranium oxides generally can command prices nearer the $17.50 level. The selling of natural UF_6 to a buyer that prefers uranium oxides sometimes requires sellers to discount their offering prices somewhat, primarily by pricing the conversion services contained therein virtually at zero.

The reduced levels of market activity that characterized August increased somewhat during September, but the market was still sluggish, due to several factors.

1. The approach of DOE's October 1 deadline for conversion to the Utility Services enrichment contract (USEC) occupied the attention of many fuel managers who might otherwise have sought to purchase natural uranium.

2. The totals of active spot and near-term uranium supply and demand changed little from previous months.

3. Of the four transactions reported, the two involving the largest quantities are attributable to negotiations begun in previous months.

4. Buyers are continuing to exercise discretion with respect to sellers' offers. Even the few buyers having firm purchase requirements are timing their entry so as to allow ample time to examine the market.

5. Sellers active in the market have been unwilling to raise their offering prices in the face of buyers' resistance, which is partially due to the continued strength of the US dollar, particularly against European currencies.

6. Several potential sellers, including producers and users having large unneeded inventories, are awaiting the appearance of additional firm demand and higher prices.

The actions of one or two potential buyers of large quantities of material (upwards of one million pounds U_3O_8) could cause substantial price movements in October, especially if sellers offer insufficient quantities at current prices. Substantial supplies would, of course, become available at higher prices, but whether such prices will materialize largely depends on how buyers approach the market. Rapid, aggressive procurement efforts probably would lead to price firming, while a more measured approach could well leave market prices relatively unchanged.

* * *

The **Conversion Value** as of September 30, 1984 is **$1.00** per pound U in UF_6, up from $0.80.

Even though the selling of natural UF_6 to a buyer that prefers uranium oxides sometimes requires sellers to discount their offering prices somewhat, primarily by pricing the conversion services contained therein virtually at zero, at least two potential buyers of secondary market conversion services have indicated their willingness to pay approximately $1.00 per pound U as UF_6.

Active supply of secondary market conversion services for delivery within three years amounts to 2.8 million pounds U in UF_6. No active secondary market conversion demand for delivery within three years, and no secondary market conversion transactions, are reported.

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PRICING

ENRICHED URANIUM AND SWUS

The Nuexco **SWU Values** as of September 30, 1984 are as follows:

1. For **DOE origin** and a tails assay of 0.30 weight-percent U_{235}:
   - a. For FY85 delivery, $115 per SWU;
   - b. For FY86 delivery, $20 discount from the USEC base price on delivery;
2. For **non-DOE origin:**
   - a. For delivery within approximately 15 months, $90 per SWU, up $5;
   - b. For delivery in calendar year 1986 (CY86), $98 per SWU.

No new secondary market SWU transactions are reported. Active near-term SWU supply on the secondary market amounts to 275,000 SWUs, while active demand amounts to 395,000 SWUs.

With this month's Report, Nuexco begins the publication of two new SWU Values, reflecting the market's shift away from 1985 and toward 1986. While there is still significant activity in the market for sales of FY85 DOE origin SWUs and CY85 non-DOE origin SWUs, some utilities have begun purchasing DOE SWUs to fill the percentage of their FY86 requirements not covered by the USEC. Buyers of non-DOE origin SWUs are also showing more interest in CY86 deliveries.

The non-DOE and FY85 SWU values are expressed as fixed prices. Typically, secondary market SWU sellers have preferred to offer enrichment services at fixed prices whenever their purchase prices have been known. Because the FY86 price will not be known until February or March of 1985, customers typically express offers for FY86 SWUs as a discount from the USEC price for FY86.

The new DOE SWU Value is referenced to *fiscal year* 1986, while the new non-DOE SWU Value is referenced to *calendar year* 1986. The three-month difference reflects the ways in which buyers of DOE SWUs and sellers of non-DOE SWUs, respectively, view the market. Nuexco also changed its reference tails assay for DOE SWUs from 0.20 weight-percent (w/o) U_{235} to 0.30 w/o U_{235}. Nuexco originally chose a reference tails assay of 0.20 w/o because it was the transaction tails assay for the holders of 3.5-year Requirements contracts (who, as buyers, dominated the secondary SWU market before the USEC was issued). However, tails assays of 0.20 w/o are no longer as prevalent as 0.30 w/o U_{235}; at present, most secondary market offers for DOE origin SWUs, especially those for FY86 delivery, are referenced to tails assays of 0.30 w/o U_{235}. In the process of converting to the USEC, many utilities have accepted assignments of excess DOE SWU commitments from other utilities. DOE's willingness to permit those buyers to vary the tails assays of the assigned enrichment services at no charge makes it more cost-effective for some of them to specify higher tails assays. Hence the choice of 0.30 w/o as the reference tails assay for DOE SWU Values.

* * *

With a perceived deadline of October 1, DOE's customers have been making strategic decisions with regard to their enrichment services requirements and conversion to the USEC. By September 28, all Japanese utilities had signed the USEC, most of them for 100-percent coverage of their enrichment requirements. In the USA, only about six utilities still intend not to convert to the USEC. In previous months, Nuexco had anticipated that DOE would have difficulty maintaining their market share in Europe. Even in Europe, however, DOE scored a relative success, particularly when Spain's ENUSA (Empresa Nacional del Uranio, S.A.), one of the major Eurodif partners, agreed to convert to the USEC.

In the process, however, DOE did lose some customers to the competition. For several customers, DOE also accepted deferrals (short-term losses) of contractual commitments in FY85 and FY86 in exchange for 100-percent coverage of their requirements as part of the negotiated conversion terms. Despite those lost SWU sales, it appears that DOE has maintained a market share that exceeds most expectations for the next five years.

Maintaining as large a market share as possible, even to the detriment of short-term revenues, appears to have been the primary objective of DOE's campaign to promote conversion to the USEC. To achieve this goal, DOE offered a lower current SWU price and, more importantly, projections of lower prices in the future. This strategy forced adjustments to DOE's accounting methods in order to establish a budget in compliance with the cost recovery rule.

Until 1974, the US government held a monopoly on sales of enrichment services to commercial nuclear power plants. Customers had had very little leverage in negotiating prices and contract terms which were subject to unilateral decisions from the US government. With the emergence of three competitors (Eurodif and Urenco in Europe; Techsnabexport in the USSR) in the mid-seventies, losses in sales became more apparent and DOE began to compare its declining market share unfavorably

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to its 100-percent market share of the early 1970s. For instance, DOE has reported that its world market share dropped from 69 percent in 1979 to 62 percent in 1984.

In support of its marketing efforts, DOE has presented itself as a non-profit organization of the US government. DOE has emphasized its greater production experience and its theoretical economy of scale. Using its own highly optimistic forecast of SWU sales, and based on the assumption that its development of new enrichment technologies will be cost-effective, DOE has projected prices well below the current SWU price ceiling. In April 1984, DOE's presentation to Congress indicated that a SWU price of $135 from 1985 through 1994 would satisfy the statutory requirement for full-cost recovery over a reasonable time period. During its recent presentations to prospective converts to the USEC, DOE has raised the prospect of SWU prices between $120 in 1987–1988 and $110 or lower in 1994. In Nuexco's opinion, DOE's published justifications are neither sufficient nor consistent enough to substantiate such projections. Even with a SWU price of $135 through 1994, if SWU sales are closer to the Nuexco estimate than that of DOE, DOE could

Table 1

DOE SALES LOSSES[1] FROM CONTRACT CANCELLATIONS[2]

Country	Reactor	Lost Sales ($M)	Replacement Supplier
Contracts Canceled:			
Federal Republic of Germany	Biblis	230	Urenco
Federal Republic of Germany	Philippsburg 2	200	Urenco
Federal Republic of Germany	Wuergassen	110	Urenco
Spain	Valdecaballeros	430	Eurodif/Techsnabexport
Spain	Lemoniz 1	280	Eurodif/Techsnabexport
Spain	Lemoniz 2	290	Eurodif/Techsnabexport
Spain	ASCO 1	280	Eurodif/Techsnabexport
Spain	ASCO 2	420	Eurodif/Techsnabexport
Spain	Almaraz 1	260	Eurodif/Techsnabexport
Spain	Almaraz 2	280	Eurodif/Techsnabexport
Spain	Cofrentes 1	260	Eurodif/Techsnabexport
Spain	Zorita 1	70	Eurodif/Techsnabexport
Spain	Garona	130	Eurodif/Techsnabexport
Sweden	OKG 3	420	Techsnabexport
Sweden	Forsmarck 3	255	Undecided
Switzerland	Beznau 2	55	Urenco
Switzerland	Leibstadt	300	Undecided
Switzerland	Goesgen	350	Undecided
USA	Seabrook 1	290	Undecided
USA	Seabrook 2	305	Undecided
	Subtotal	$5,215	
Loss of New Sales:			
South Korea	Units 9 & 10	200	Eurodif
Taiwan	Units 7 & 8	300	Eurodif
	Total Lost Sales	$5.7 Billion	

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[1] Through March 1, 1984.

[2] Refers to cancellations of entire contracts, not partial terminations.

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find itself in the red by several billions of dollars rather than at a breakeven point in 1994. Prices lower than $135 would produce even higher losses.

The low-cost production capability, much needed to lower SWU prices, demands substantial revenues for its implementation. The current DOE financial condition makes it an uncertain consideration. This critical financial condition is the result of significant losses in sales experienced by DOE during a period of major capital expansion. For instance, DOE reported as of March 1, 1984 that since 1979 twenty contracts were canceled, a total amount in lost sales of about $5.7 billion. The canceled contracts are detailed in Table 1. Additional deliveries amounting to a loss in enrichment sales in excess of $2 billion were canceled as part of partial contract terminations. Nuexco's analysis indicates DOE lost business has increased by approximately ten percent in the past seven months.

What are the most important reasons for DOE's success in persuading customers to convert to the USEC in higher than anticipated percentages? DOE's projections of future market demand and of their own SWU pricing policy did not constitute a convincing argument for conversion to the USEC based on purely economic considerations; adequate supporting information was not provided. DOE also undertook a major marketing effort, but the real reasons for DOE's success lie elsewhere.

1. DOE exploited nationalism and political considerations in the USA that establish a bias toward domestic supply.

2. In the Far East, DOE obtained maximum advantage from Japanese concerns for security of supply and political considerations such as foreign trade and national security. However, these same considerations, which are not price-sensitive, will become less important as additional enrichment capabilities are developed locally as part of national programs. In a market where all enrichment suppliers will be operating well below capacity, a trend toward local enrichment would substantially reduce DOE sales. Just three utilities in Japan, for instance, take about 14 percent of the DOE production.

3. In Europe, DOE offered very liberal conversion terms, such that their decidedly price-conscious European customers found it easier than expected to accept the USEC.

With so many unknowns and so many likely obstacles, it will be very difficult for DOE to recover its costs fully by 1995. If it fails to do so, and if DOE's Japanese and European customers turn to local suppliers, the only sources of revenues that will remain to cover potentially tremendous losses will be US utilities (ratepayers) and the US government (taxpayers).

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CURRENT MARKET DATA

September 30, 1984	Market Values	Active Supply[1] (thousands)	Active Demand[1] (thousands)
EXCHANGE VALUE	**$17.50**/lb. U_3O_8	5,490	955
CONVERSION VALUE	**$1.00**/lb. U in UF_6	2,825	0
SWU VALUES		275	395
DOE origin, 0.3 tails assay			
FY85 delivery	**$115**/SWU		
FY86 delivery	**$20** discount/SWU		
non-DOE origin, delivery within 15 months	**$90**/SWU		
non-DOE origin, CY86 delivery	**$98**/SWU		
LOAN USE CHARGE RATE	**6%**/annum	0	0

TRANSACTION VALUE

$/lb. U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
16.55	4.3	12	5

DEFINITIONS

1. The **Exchange Value** is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.
2. The **Conversion Value** is Nuexco's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.
3. The **SWU Values** represent Nuexco's judgment of the price at which transactions for the sale of significant quantities of SWUs of stated origin for delivery in the specified time period could be concluded as of the date indicated.
4. The **Loan Use Charge Rate** is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.
5. The **Transaction Value** is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:
   a. Transactions closed within the previous three-month period for which delivery is scheduled within one year of the transaction date;
   b. At least ten transactions;
   c. Transactions involving a sum total of at least 2 million pounds U_3O_8 equivalent.

   The sample time is extended as necessary to include these minima. Other currencies are converted to US dollars using conversion rates in effect on or near the transaction date.

DERIVATIONS AND COMMENTS

1. All Market Values are based on:
   a. Data from recently completed transactions.
   b. Data from pending transactions.
   c. Firm bids to buy or borrow, and firm offers to sell or lend.
   d. Prices purchasers or rates borrowers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy or borrow, and prices sellers or rates lenders have expressed a willingness to offer, but for which Nuexco is not aware of firm offers to sell or lend.
2. Prices associated with deliveries under old or renegotiated contracts or other than arm's-length transactions are not considered in the determination of these Market Values.
3. In the determination of the Conversion Value, Nuexco does not consider transportation charges other than those customarily provided by primary suppliers of conversion services.
4. The prices of conversion services or SWUs delivered under long-term contracts with primary suppliers are not considered in the determination of either the Conversion Value or SWU Value.
5. For the DOE SWU Values, Nuexco converts SWU prices at varying tails and product assays to equivalent SWU prices at a tails assay of 0.30 weight-percent U_{235} and a product assay of 3.0 weight-percent U_{235}, assuming feed costs corresponding to the Nuexco Exchange and Conversion Values determined as of the same date.
6. In calculating the Transaction Value, Nuexco does not account for the price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of future Exchange Values or any other indeterminant variable. Also excluded from the calculation are any other transactions in which the delivery price is defined in such a way that it cannot currently be determined.

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[1] Supply and demand tables in the *Current Market Data* section of this Report detail the numbers for each category. Quantities of SWUs (Separative Work Units) are not referenced to a particular origin.

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CURRENT MARKET DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
Country (currency)	This Month (Sept. 30, 1984)	Last Month (August 31, 1984)	12 Months Ago (Sept. 30, 1983)	This Month (Sept. 30, 1984)	Last Month (August 31, 1984)	12 Months Ago (Sept. 30, 1983)
Australia (dollar)	20.96	20.60	26.74	54.49	53.56	69.52
Belgium (comm. franc)	1,072	1,018	1,284	2,786	2,647	3,338
Canada (dollar)	23.05	22.71	29.59	59.92	59.03	76.92
Finland (markka)	110.06	105.87	136.29	286.14	275.23	354.31
France (franc)	162.04	154.87	192.62	421.26	402.62	500.76
FRG (mark)	53.05	50.49	63.41	137.91	131.26	164.85
Italy (lira)	32,901	31,418	38,400	85,535	81,681	99,831
Japan (yen)	4,280	4,220	5,683	11,126	10,971	14,775
Netherlands (guilder)	59.50	56.91	70.88	154.70	147.95	184.27
South Africa (rand)	29.17	27.34	26.45	75.83	71.09	68.75
Spain (peseta)	2,959	2,884	3,653	7,693	7,498	9,497
Sweden (krona)	149.83	145.11	188.09	389.52	377.25	488.99
Switzerland (franc)	43.68	41.96	51.15	113.57	109.08	132.98
UK (pound)	14.05	13.34	16.03	36.52	34.68	41.68
US (dollar)	17.50	17.50	24.00	45.50	45.50	62.39

TRANSACTION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

	per lb. U_3O_8 in Concentrates			per kg. U in Concentrates		
Country (currency)	This Month (Sept. 30, 1984)	Last Month (August 31, 1984)	12 Months Ago (Sept. 30, 1983)	This Month (Sept. 30, 1984)	Last Month (August 31, 1984)	12 Months Ago (Sept. 30, 1983)
Australia (dollar)	19.82	19.31	26.35	51.53	50.19	68.51
Belgium (comm. franc)	1,013	954.04	1,265	2,635	2,480	3,290
Canada (dollar)	21.80	21.28	29.15	56.67	55.32	75.79
Finland (markka)	104.09	99.21	134.30	270.61	257.93	349.15
France (franc)	153.24	145.13	189.91	398.39	377.31	493.46
FRG (mark)	50.17	47.32	62.48	130.42	123.01	162.44
Italy (lira)	31,115	29,443	37,840	80,892	76,546	98,376
Japan (yen)	4,047	3,955	5,600	10,522	10,281	14,559
Netherlands (guilder)	56.27	53.33	69.85	146.30	138.65	181.59
South Africa (rand)	27.58	25.63	26.06	71.71	66.62	67.75
Spain (peseta)	2,798	2,703	3,600	7,275	7,026	9,358
Sweden (krona)	141.70	135.99	185.34	368.38	353.54	481.86
Switzerland (franc)	41.31	39.32	50.40	107.40	102.22	131.04
UK (pound)	13.29	12.50	15.80	34.54	32.50	41.07
US (dollar)	16.55	16.40	23.65	43.03	42.64	61.48

[1] Calculated using currency exchange rates published in the *Wall Street Journal* on September 28, 1984.

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CONVERSION VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	per lb. U as UF_6			per kg. U as UF_6		
	This Month (Sept. 30, 1984)	Last Month (August 31, 1984)	12 Months Ago (Sept. 30, 1983)	This Month (Sept. 30, 1984)	Last Month (August 31, 1984)	12 Months Ago (Sept. 30, 1983)
Australia (dollar)	1.20	0.94	1.11	2.64	2.08	2.46
Belgium (comm. franc)	61.24	46.54	53.50	135.00	102.60	117.96
Canada (dollar)	1.32	1.04	1.23	2.90	2.29	2.72
Finland (markka)	6.29	4.84	5.68	13.87	10.67	12.52
France (franc)	9.26	7.08	8.03	20.41	15.61	17.69
FRG (mark)	3.03	2.31	2.64	6.68	5.09	5.82
Italy (lira)	1,880	1,436	1,600	4,145	3,166	3,527
Japan (yen)	244.56	192.91	236.80	539.16	425.29	522.05
Netherlands (guilder)	3.40	2.60	2.95	7.50	5.74	6.51
South Africa (rand)	1.67	1.25	1.10	3.67	2.76	2.43
Spain (peseta)	169.09	131.84	152.21	372.78	290.66	335.56
Sweden (krona)	8.56	6.63	7.84	18.88	14.62	17.28
Switzerland (franc)	2.50	1.92	2.13	5.50	4.23	4.70
UK (pound)	0.80	0.61	0.67	1.77	1.34	1.47
US (dollar)	1.00	0.80	1.00	2.20	1.76	2.20

SWU VALUES EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES[1]

Country (currency)	DOE SWU FY85 (September 30, 1984)	DOE SWU FY85 (August 31, 1984)	Non-DOE SWU delivery within 15 months (September 30, 1984)	Non-DOE SWU delivery within 15 months (August 31, 1984)
Australia (dollar)	137.72	117.72	107.78	100.06
Belgium (comm. franc)	7,042	5,817	5,511	4,945
Canada (dollar)	151.46	129.75	118.53	110.29
Finland (markka)	723.27	604.96	566.04	514.22
France (franc)	1,065	884.96	833.33	752.21
FRG (mark)	348.59	288.52	272.81	245.24
Italy (lira)	216,206	179,533	169,205	152,603
Japan (yen)	28,124	24,114	22,010	20,497
Netherlands (guilder)	391.02	325.20	306.02	276.42
South Africa (rand)	191.67	156.25	150.00	132.81
Spain (peseta)	19,445	16,480	15,218	14,008
Sweden (krona)	984.59	829.19	770.55	704.81
Switzerland (franc)	287.07	239.75	224.66	203.79
UK (pound)	92.32	76.22	72.25	64.79
US (dollar)	115.00	100.00	90.00	85.00

[1] Calculated using currency exchange rates published in the *Wall Street Journal* on September 28, 1984.

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CURRENT MARKET DATA

RECENT TRANSACTIONS[1]

Uranium Sales

Nuexco Transaction Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as Percent of Current E.V.	Seller	Buyer	Remarks
3122	1986-90	1,001-1,500	see remarks	Australian Producer	European Utility	Related to market price; subject to government guidelines.
3121	1986-90	301-600	see remarks	US Producer	European Trader	Partial advance payment, plus fixed price on delivery.
3115	1984	301-600	96	African Producer	European Utility	UF_6.
3114	1984	50-100	94	European Entity	US Producer	

[1] Transactions listed are not limited to those in which Nuexco was involved, but also include others of which Nuexco is aware.

No secondary market enrichment transactions this month.

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URANIUM SUPPLY
(September 30, 1984)

	Delivery Period[1] (Thousands of Pounds U_3O_8)		
Nuexco Project Number	**Spot or Near-term[2]**	**Intermediate or Long-term**	**Remarks**
Available for Sale:			
ACTIVE			
1575	500	500 per year	
1860	400	1,500 per year	
2038	1,000	1,000 per year	UF_6
2236	—	200 per year	1985-89
2263	—	500 per year	1985-90
2275	150	—	
2288	45	—	UF_6
2336	—	250 per year	
2368*	—	250 per year	1987-90
2392	35	—	UF_6
2429*	900	—	
2484	130	—	
2499	15	—	
2509	1,200	1,600	UF_6
2516*	200	—	
2538*	15	—	
2565	400	—	
2574*	500	—	UF_6
TOTAL:	5,490		
INACTIVE			
0564	—	1,000 per year	1985-90
2191	125	—	UF_6
2193	—	800 per year	1986-90
2271	—	500 per year	1984-88
2297*	—	200 per year	1986-89
2326*	—	1,000 per year	1989-91
2335*	275	—	
2389	300	—	
2473	—	500 per year	1984-90
2495	130	—	UF_6
2514	—	1,000 per year	
2553	300	—	
TOTAL:	1,130		

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*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

Projects removed since last month: 1818, 2201, 2489, 2521, 2556

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CURRENT MARKET DATA

URANIUM DEMAND
(September 30, 1984)

	Delivery Period[1] (Thousands of Pounds U_3O_8)		
Nuexco Project Number	Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2217	—	1,000 per year	1988-95
2419*	155	—	1985
2528	—	250 per year	1991 on
2555*	—	150 per year	1986-91
2563*	800	—	UF_6
TOTAL:	955		
INACTIVE			
1999	—	50 per year	1985-90
2244	—	350 per year	1987 on
2329*	500	—	1985
2414	—	150 per year	1987-91
2442	—	250 per year	1986 on
2457	—	350 per year	1988 on
2506*	50	—	U_3O_8 or UF_6
2507	—	300	1987-88
2542A	—	1,400	1990; UF_6e
TOTAL:	550		

*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes material deliverable within one year under other than spot or near-term contracts.

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LOAN SUPPLY AND DEMAND
(September 30, 1984)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U_3O_8) Within 1 Year	Beyond 1 Year	Remarks
Available for Loan:			
INACTIVE			
1938	2,000	—	UF_6
2128*	700	—	
2139	2,000	—	
2483	550	—	
TOTAL:	5,250		

*New or revised since last month.

[1] Measured from the date of this Report.

No inquiries to borrow this month.

CONVERSION SUPPLY AND DEMAND
(September 30, 1984)

Nuexco Project Number	Delivery Period[1] (Thousands of Pounds U as UF_6) Within 3 Years	Beyond 3 Years	Remarks
Available for Sale:			
ACTIVE			
2141	2,600	—	
2560	225	—	
TOTAL:	2,825		
INACTIVE			
2051	1,000	—	
2438	500	250	1985-87
2511	600	700	1986-90
TOTAL:	2,100		
Inquiries to Purchase:			
INACTIVE			
2420	300	—	1986
TOTAL:	300		

*New or revised since last month.

[1] Measured from the date of this Report.

Projects removed since last month: 2401, 2456B.

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SWU SUPPLY
(September 30, 1984)

	Delivery Period[1] (Thousands of SWUs)		
Nuexco Project Number	**Spot or Near-term[2]**	**Intermediate or Long-term**	**Remarks**
Available for Sale:			
ACTIVE			
2100	—	100 per year	1986-87
2164	80	—	
2285	—	1,000	
2408	—	65	1986
2428	80	40	
2510*	40	50	
2513*	25	25	1986
2517*	—	150	1989
2589*	50	—	
TOTAL:	275		
INACTIVE			
2192	10	—	
2359*	180	—	
2531*	—	150	1987
2571*	—	55	1987
2580*	150	—	
2583*	50	—	
TOTAL:	390		

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*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.
Projects removed since last month: 2550.

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SWU DEMAND
(September 30, 1984)

	Delivery Period[1] (Thousands of SWUs)		
Nuexco Project Number	Spot or Near-term[2]	Intermediate or Long-term	Remarks
Inquiries to Purchase:			
ACTIVE			
2443*	100	—	
2452	30	—	1985
2471	—	40 per year	1986-90
2480*	100	—	
2519	—	30 per year	1987 on
2543*	—	20	1986
2562	15	30	1986
2564*	—	100	1986
2579*	150	—	
TOTAL:	395		
INACTIVE			
2459	—	50 per year	1987 on
2500*	—	130	1987-90
2503*	—	330	1986
2512	—	15 per year	1987 on
2552	35	—	
2578*	—	150	1986
TOTAL:	35		

*New or revised since last month.

[1] Measured from the date of this Report.

[2] For delivery within one year. This category excludes SWUs deliverable within one year under other than spot or near-term contracts.

Projects removed since last month: 2449, 2454, 2479, 2542B, 2600.

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JAPAN'S NUCLEAR FUEL FABRICATORS

Introduction

Japan's nuclear industry has achieved essentially complete domestic capability to supply its needs for fabrication of nuclear fuel. When current expansion programs are complete, three companies will have the facilities to fabricate a combined total of approximately 1,700 short tons of UO_2 annually for BWR and PWR fuel. Japan Nuclear Fuel (JNF), Mitsubishi Nuclear Fuel (MNF) and Nuclear Fuel Industries (NFI) are producing fuel for initial cores and reloads and meeting utility delivery schedules.

Fabrication

JNF fabricates BWR fuel based on a technical license obtained from General Electric (G.E.) of the USA. Similarly, Westinghouse licenses MNF for the manufacture of PWR fuel. The two licensors actively participate in the ownership of the Japanese companies. Both G.E. and Westinghouse have representation on the respective Boards of Directors, in addition to providing a US officer in the company. During the initial phases of Japan's commercial lightwater reactor (LWR) generation program in the mid-1960s, the two US manufacturers negotiated licensing agreements with Japanese nuclear hardware makers for the basic LWR technology (Report 185). Joint ventures materialized and became the basis for today's nuclear licensing agreements. Hitachi and Toshiba, Japan's BWR vendors, collaborate with G.E. in JNF. Mitsubishi Heavy Industries (MHI), Japan's PWR supplier, is part owner of MNF with Westinghouse (Table 2).

The nuclear fuel fabrication and research activities of Furukawa Electric and Sumitomo Electric combined to form NFI in the early 1970s. NFI, which manufactures fuel for both BWRs and PWRs, was established in response to the Japanese government's and utilities' desire for an alternate domestic LWR fuel supplier. Technical agreements with Babcock and Wilcox in the USA for PWR fuel design and manufacturing expertise, and with Kraftwerk Union (KWU) in Germany for BWR technology, as well as cross-licensing with G.E. on specific BWR fuel patents, enhanced NFI capabilities. NFI's separate facilities consist of Tokai Works in the Ibaragi Prefecture for BWR fuel, and Kumatori Works in Osaka for PWR fuel.

Initial Core

Japanese utilities normally purchase the initial core for a new reactor from the supplier of the nuclear steam sup-

Table 2

JAPAN NUCLEAR FUEL MANUFACTURERS

Company	Plant Name and Location	Type of Fuel	Annual Capacity (tons UO_2 per year) Current	Projected	Ownership
Japan Nuclear Fuel (JNF)	Kurihama Works Kanagawa Prefecture	BWR	490	750	Hitachi—30% Toshiba—30% G.E.—40%
Mitsubishi Nuclear Fuel (MNF)	Tokai Works Ibaragi Prefecture	PWR	420	600-650	MHI[1]—15% Mitsubishi Metals—51% Westinghouse—34%
Nuclear Fuel Industries (NFI)	Tokai Works Ibaragi Prefecture	BWR	100	not established	Furukawa Elec.—50% Sumitomo Elec.—50%
	Kumatori Works Osaka	PWR	265		

[1] Mitsubishi Heavy Industries.

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ply system (NSSS). Hitachi and Toshiba, the BWR suppliers, perform basic core and fuel design and subcontract for fuel manufacture to JNF. The NSSS supplier, not the fuel manufacturer, provides mechanical and burnup warranties for the fuel. In a similar way, MHI subcontracts to MNF for supply of initial core PWR fuel. G.E. and Westinghouse also have participated in the supply of several reactors in Japan. Prior to the formation of JNF and MNF, fuel for those reactors came from US suppliers, but joint ventures in Japan provided initial core fabrication for subsequent projects. NFI has not supplied initial cores for LWR plants.

Reload Fuel

Utility contracting procedures for reload fuel vary depending on reactor type. For BWR reloads, the reactor supplier provides fuel and core management, while subcontracting for fuel fabrication, primarily to JNF. NFI has received only a few partial reload fuel contracts to date from original plant suppliers, usually at the plant owner's request. However, in recent years, the PWR utilities have given some reload fuel orders directly to NFI. PWR plant owners generally follow the same method and contract with MHI for reload fuel to be fabricated by MNF. While G.E. has received continuing BWR reload orders for reactors it originally supplied in Japan, Westinghouse has had only minimal direct participation in PWR reload activities.

Conversion

The conversion of enriched UF$_6$ to UO$_2$ for the manufacture of LWR fuel pellets is one area in which Japan has yet to achieve complete domestic capability. Current conversion capacity is less than 1,000 short tons UO$_2$ per year, well under the planned annual fuel fabrication capacity of the three manufacturers (1,700 tons UO$_2$). Currently, MNF has conversion capacity of 420 tons UO$_2$ annually, adequate for its current fuel fabrication capacity only. Neither NFI nor JNF has conversion facilities.

Japan Nuclear Fuel Conversion (JCO), established in 1979 and wholly owned by Sumitomo Metal Mining Company, has recently expanded its conversion capacity to 500 short tons UO$_2$ per year. JCO currently supplies all of NFI's and a portion of JNF's UO$_2$ conversion requirements. G.E. in the USA handles JNF's remaining needs for UO$_2$ conversion. JCO is evaluating plans to further expand capacity to meet expected future domestic demand.

The production of Zircaloy tubing for PWR (Sumitomo Metal Industry and Mitsubishi Metal Industry) and BWR (Kobe Steel) fuel manufacture has been sufficient for Japan's nuclear industry. Zirconium ingots for tube manufacture, however, are still imported. Mitsui Company, Ishizuka Laboratories and Nippon Mining are planning to form a joint venture to produce 1,000 short tons of elemental zirconium annually beginning in 1986. All other fuel-related components are available from established domestic suppliers, except some tubing for newer, high performance BWR fuels and miscellaneous parts that are still imported.

Because of the lack of indigenous uranium deposits, the Japanese utilities will continue to rely on overseas supply of uranium for their nuclear fuel needs. Nuexco estimates that current inventory and deliveries under long-term contracts are adequate for needs through the late 1990s. Currently, Japan is dependent on foreign supply of uranium enrichment services, predominantly from the USDOE and, to a small extent, from Eurodif. Although overseas enrichment capacity is adequate to supply Japanese utilities' requirements through the year 2000, Japan nevertheless is proceeding with plans for a domestic enrichment facility. (See Report 189 and Report 193.) Latest plans call for an enrichment plant that could produce 1.5 million SWUs per year by 1997, a target that would cover approximately 20 percent of Japan's annual needs. Security of enrichment supply, rather than strict economic factors, appears to be the impetus behind the development effort.

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RECENT DEVELOPMENTS

AUSTRALIA

The Australian government has enforced its ban on uranium exports to France by refusing to grant Queensland Mines, Ltd. (QML) an export license for next month's delivery. Although the ban was officially declared in early 1983 and re-affirmed by the Australian Labor Party (ALP) national conference last July, it lingered ineffectually until new shipments were due under the QML contract with Electricite de France (EdF). The contract was negotiated in 1981 and calls for 6.8 million pounds U_3O_8 to be delivered between 1982 and 1988.

Hoping to placate domestic opposition to its uranium policy, the ALP enacted the ban as a political protest against French weapons tests in the Pacific Ocean. However, the wide supply base for uranium in France indicates that the ban on Australian material will prove rather futile. Furthermore, the government's recent parliamentary fact-finding mission discovered that the French government enjoys widespread domestic support for its nuclear policy, including its weapons program. Therefore, the pattern of weapons tests is not likely to change in the immediate future.

If effective, the uranium ban could become very costly for Australia as a trading nation. While the ALP had gained the support of the Australian business community, political actions that damage international trade could erode that support. QML faces customer and revenue losses, and the ban similarly affects Western Mining, whose prospects of achieving baseload tonnage for Roxby Downs without sales to France are remote.

* * *

After the takeover of Getty Oil by Texaco, Inc., its 35 percent stake in Pancontinental's Jabiluka deposit is for sale together with Getty's other mining interests. BHP, Australia's largest company, is investigating the purchase of Getty Mining Company from Texaco. However, BHP is not interested in acquiring the Jabiluka mine. BHP interests have not included uranium because of concerns that anti-uranium sentiments could damage the credibility and effectiveness of its other operations.

JAPAN

Report 186 (February 1984) presented an annual review of Japan's commercial nuclear generation program. The Ministry of International Trade and Industry (MITI), the government agency responsible for long-term economic planning, had established revised goals for nuclear electricity generating capacity to be in operation by:

1990—34,000 MWe;
1995—48,000 MWe;
2000—62,000 MWe.

Recently, a select MITI Advisory Committee for Energy reviewed those objectives, and, citing the need to emphasize nuclear power as a long-term alternative to oil-fired generation facilities, confirmed the desirability of MITI's goals for Japan's private utility sector. It also confirmed that Japanese utilities' current inventories, combined with deliveries scheduled under long-term contracts, totaled approximately 400 million pounds U_3O_8 equivalent and were adequate to meet cumulative needs through 1995. It concluded, however, that the utilities would require an additional 120 million pounds U_3O_8 equivalent to meet the power generation goals for the year 2000. The committee further suggested that at least half of the remaining requirements be secured via the participation of Japanese entities in overseas development projects, with the remainder supplied by long-term contracting from overseas producers.

The committee report could lead to speculation that the utilities might initiate significant uranium procurement efforts over the next several years, primarily based on their demonstrated concern for security of supply. In Nuexco's evaluation, however, the MITI goals for 1995 and 2000 are overly optimistic. Even with the ability demonstrated by Japanese utilities in recent years to license and build nuclear power plants on schedule, it is doubtful that the MITI goals for 1995 and 2000 will be realized. To achieve 48,000 MWe installed capacity by 1995 would require the addition of 14,000 MWe to the 1990 MITI goal of 34,000 MWe, a rate of 2,800 MWe per year over a five-year period. With current construction progress, however, Nuexco expects an average annual capacity addition of 1,700 MWe. Tables 3 and 4 present a current update on Japanese nuclear plants operating, under construction or in licensing. The latter category includes active plant projects with commercial operation dates in the first half of the 1990s. In recent months, several plants under construction, or in licensing with 1990–1995 operation targets, have been delayed one to two years.

In the next few years, sites will be confirmed for an additional five to six plants scheduled for commercial operation between 1992 and 1995. Moreover, long-term con-

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tracts with deliveries continuing well into the 1990s indicate that most Japanese utility uranium inventories will continue to grow beyond current levels. However, three factors support Nuexco's opinion that present long-term contract deliveries of U_3O_8 will be adequate for this century.

1. Utilities must address the impact of the DOE's USEC contract on their current uranium inventories. Conversions to the USEC will reduce needs for future deliveries.

2. A MITI goal of 39,000-41,000 MWe nuclear capacity installed by 1995, and correspondingly reduced requirements, would be more realistic.

3. It is more difficult to project installed capacity for the year 2000, but significant reductions in MITI's targets and their associated requirements are likely.

Table 3

JAPANESE NUCLEAR POWER UNITS
UNDER CONSTRUCTION AND UNDERGOING LICENSING

Unit	Utility	Capacity (MWe net)	Type	Estimated Commercial Operation
Under Construction				
Takahama 3	Kansai EPC[1]	870	PWR	Feb 1985
Fukushima II-3	Tokyo EPC	1100	BWR	Jul 1985
Takahama 4	Kansai EPC	870	PWR	Aug 1985
Kashiwazaki 1	Tokyo EPC	1100	BWR	Oct 1985
Sendai 2	Kyushu EPC	890	PWR	Mar 1986
Tsuruga 2	JAPC[2]	1160	PWR	Jun 1987
Hamaoka 3	Chubu EPC	1100	BWR	Sep 1987
Fukushima II-4	Tokyo EPC	1100	BWR	Sep 1987
Shimane 2	Chugoku EPC	820	BWR	Sep 1988
Kyowa Tomari 1	Hokkaido EPC	579	PWR	Jun 1989
Kashiwazaki 5	Tokyo EPC	1100	BWR	Apr 1990
Kashiwazaki 2	Tokyo EPC	1100	BWR	Oct 1990
Kyowa Tomari 2	Hokkaido EPC	579	PWR	Jun 1991
Undergoing Licensing				
Ikata 3	Shikoku EPC	890	PWR	Oct 1990
Genkai 3	Kyushu EPC	1180	PWR	Mar 1993
Maki 1	Tohoku EPC	825	BWR	Mar 1994
Genkai 4	Kyushu EPC	1180	PWR	Mar 1994
TOTAL MWe		16,443		

[1] EPC = Electric Power Company.
[2] JAPC = Japan Atomic Power Company.

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Table 4
COMMERCIALLY OPERATING NUCLEAR POWER PLANTS IN JAPAN

Unit	Utility	Capacity (MWe net)	Type	Commercial Operation
Tokai 1	JAPC[1]	166	GCR	Jul 1966
Tsuruga 1	JAPC	357	BWR	Mar 1970
Mihama 1	Kansai EPC[2]	340	PWR	Nov 1970
Fukushima I-1	Tokyo EPC	460	BWR	Mar 1971
Mihama 2	Kansai EPC	500	PWR	Jul 1972
Shimane 1	Chugoku EPC	460	BWR	Mar 1974
Fukushima I-2	Tokyo EPC	784	BWR	Jul 1974
Takahama 1	Kansai EPC	826	PWR	Nov 1974
Genkai 1	Kyushu EPC	559	PWR	Oct 1975
Takahama 2	Kansai EPC	826	PWR	Nov 1975
Fukushima I-3	Tokyo EPC	784	BWR	Mar 1976
Hamaoka 1	Chubu EPC	540	BWR	Mar 1976
Mihama 3	Kansai EPC	826	PWR	Dec 1976
Ikata 1	Shikoku EPC	566	PWR	Sep 1977
Fukushima I-5	Tokyo EPC	784	BWR	Apr 1978
Fukushima I-4	Tokyo EPC	784	BWR	Oct 1978
Tokai 2	JAPC	1100	BWR	Nov 1978
Hamaoka 2	Chubu EPC	840	BWR	Nov 1978
Ohi 1	Kansai EPC	1175	PWR	Mar 1979
Fukushima I-6	Tokyo EPC	1100	BWR	Oct 1979
Ohi 2	Kansai EPC	1175	PWR	Dec 1979
Genkai 2	Kyushu EPC	559	PWR	Mar 1981
Ikata 2	Shikoku EPC	566	PWR	Mar 1982
Fukushima II-1	Tokyo EPC	1100	BWR	Apr 1982
Fukushima II-2	Tokyo EPC	1100	BWR	Feb 1984
Onagawa 1	Tohoku EPC	524	BWR	Jun 1984
Sendai 1	Kyushu EPC	890	PWR	Jul 1984
TOTAL MWe		19,691		

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[1] JAPC = Japan Atomic Power Company.
[2] EPC = Electric Power Company.

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SWITZERLAND

In a popular vote held September 23, the Swiss public soundly repudiated two initiatives designed to curtail the future use of nuclear power. While the referendum attracted only 41 percent (1.7 million) of eligible Swiss voters, the nation's vocal anti-nuclear minority turned out in full force. Thus, the rejection of the initiatives was a solid victory for the Swiss utilities. That was particularly true for Kernkraftwerk Kaiseraugst AG (KWK), because the approval process for construction of its long-delayed nuclear unit had been postponed until the results of the initiatives were known. Currently, four units are in commercial operation in Switzerland, while one unit (Leibstadt) probably will achieve that status in the coming weeks (Table 5).

One of the initiatives, proposing a "future without atomic power plants," was rejected by 55 percent of the voters. The other initiative, calling for a secure supply of energy, greater conservation, and the use of "environmentally friendly" energy sources, was rejected by 54 percent. The latter initiative, if accepted, would have imposed a moratorium of indefinite length on the construction of any power plant having a capacity of more than 35 Megawatts.

A majority of voters rejected the initiatives in fifteen of Switzerland's twenty cantons and in four of its six half-cantons. Notably, all of the five cantons that approved the measures had voting turnouts below 35 percent, and all are located in the French and Italian speaking parts of the country, which are also the least industrialized and the farthest from existing nuclear units. (Two majority French-speaking cantons, Fribourg and Valais, rejected the initiatives decisively.) The two populous half-cantons of Basel, which is located 13 kilometers from the Kaiseraugst site on the Rhine River, were the only regions that voted overwhelmingly in favor of the initiatives.

The utilities and the government mounted a formidable campaign against the initiatives, stressing the positive aspects of nuclear power and the need for the country to preserve its options for future electricity requirements. Nevertheless, the utilities had not been optimistic about the outcome, and they reacted to the results with great satisfaction. Proponents of the initiatives had been collecting signatures and campaigning for more than two years. In recent months, their position had been weakened somewhat by the controversy in central Europe over acid rain, a byproduct of coal and oil combustion, both of which would be increased if the use of nuclear energy were curtailed. The nuclear opponents tried to link the dying forest problem with radiation from nuclear power plants, but met with little success.

Kernkraftwerk Kaiseraugst (KWK), more than a decade behind its original schedule for the Kaiseraugst unit, now must await a vote in the lower house (Nationalrat) of the Swiss Parliament before starting the procedure for obtaining a nuclear plant construction permit. The vote probably will take place in the spring of 1985. Switzerland's Federal Council (Bundesrat) authorized the unit in October 1981, and the upper house (Staenderat) ratified that decision in February 1983. In November 1983, a committee for the Nationalrat recommended full parliamentary approval. If the Nationalrat does grant approval, the process of obtaining a construction permit will take approximately three years. A number of design issues will be debated, including the problem of cooling towers, which the government at one time promoted in place of river cooling, but more recently intimated it favors as merely a back-up to river cooling at times of low flow or high water temperature. If construction begins in 1988, the unit could be in commercial service by 1994. If and when the path is cleared for Kaiseraugst, Kernkraftwerk Graben AG might start the approval process for construction of its Graben unit, originally scheduled for service in 1979.

Table 5

NUCLEAR POWER UNITS IN SWITZERLAND

Unit				
Operating	**Utility**	**MWe**	**Type**	**COD[1]**
Beznau 1	NOK[2]	350	PWR	Dec 1969
Beznau 2	NOK	350	PWR	Mar 1972
Muehleberg	BKW[3]	320	BWR	Oct 1972
Goesgen	KKG[4]	920	PWR	Nov 1979
Leibstadt	KKL[5]	925	BWR	Oct 1984
Planned				
Kaiseraugst	KWK[6]	925	BWR	1993
Graben	KWG[7]	1,140	BWR	indefinite

[1] Actual or expected Commercial Operation Date.
[2] NOK = Nordostschweizerische Kraftwerk AG.
[3] BKW = Bernische Kraftwerk AG.
[4] KKG = Kernkraftwerk Goesgen-Daeniken AG.
[5] KKL = Kernkraftwerk Leibstadt AG.
[6] KWK = Kernkraftwerk Kaiseraugst AG.
[7] KWG = Kernkraftwerk Graben AG.

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RECENT DEVELOPMENTS

UNITED STATES

Intercontinental Energy Corporation (IEC) announced in September that its acquisition of the Lamprecht uranium mine (in situ leach project) from Westinghouse has been approved by the Texas regulatory authorities and the transfer is complete. IEC announced the original acquisition agreement on October 20, 1983, but the property transfer had been delayed by Texas regulatory authorities until September 1984. The mine is immediately adjacent to IEC's Zamzow in situ leach uranium mine in Three Rivers, Texas.

In exchange for IEC's agreement to take title to the facilities and remaining uranium resources, Westinghouse paid IEC $600,000 in cash and also purchased an annuity which will pay a trustee acceptable to regulatory authorities ten annual installments of $1.2 million starting in 1990. The trustee will use these funds to reimburse IEC for clean-up costs of the property when mining operations cease. The trustee will pay any remaining funds to IEC. By Nuexco's estimate, an annuity of the type described could be purchased currently for approximately $4 million. Thus, the total cost to Westinghouse of the property transfer comes to $4–5 million in today's dollars.

Wyoming Mineral Corporation, a Westinghouse subsidiary, owned and operated the Lamprecht mine and suspended production from it and three other uranium operations in 1981. Nuexco estimates that the in situ leach mine contains 3 to 4 million pounds U_3O_8 at a grade of 0.05 percent. The ion exchange mill, with a production capacity of 500,000 pounds U_3O_8 per year, began recovery in 1975 and was shut down in 1981. IEC has been acquiring leases in the vicinity of the Lamprecht site, which could prolong uranium operations.

* * *

Shelby Brewer resigned from his post as assistant secretary for nuclear energy in the Department of Energy to become vice-president of operations of the Nuclear Power Systems Division of Combustion Engineering, Inc. (CE). Brewer submitted his resignation on August 22, effective September 1, at which time he assumed his new position. On January 1, 1985, he is scheduled to succeed the retiring John West as senior vice-president of the same division at CE. Although Brewer has attracted Congressional criticism over the allocation of funding for the promotion of nuclear power, DOE reports that Brewer simply received a better offer from CE. DOE has yet to announce a replacement, but Anthony Buhl reportedly is in line to succeed Brewer. Buhl is a vice-president of Technology for Energy Corporation (TEC) in Knoxville, Tennessee, and has been active in the Industry Degraded Core (IDCOR) research program.

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URANIUM IN THE USSR

Introduction

The Soviet Union hosted the 27th International Geological Congress (IGC) August 4 through August 14, 1984. More than 6000 geologists from 104 countries attended the meeting, which presented 3,200 technical papers covering every aspect of geology. The uranium portion included 50 papers, primarily on uranium deposits in sandstone and metamorphic rocks, presented to about 300 Congress members.

The IGC sponsored almost 400 geology field trips, the most noteworthy of which was a five-day trip to the Krivoi Rog iron/uranium district in the south-central Ukraine. The trip's primary objective was the promotion of scientific dialogue between the Soviet scientists and their guests. A lecture on the Krivoi Rog iron ore basin preceded the excursion, and was followed by visits to two open pit iron mines and the underground Novaya uranium mine in Zholtye Vody. The excursion continued northward to Kiev to visit the Metallogeny Department of the Ukraine Academy of Sciences and the Institute of Geochemistry and Physics of Minerals.

Zholtye Vody Uranium Deposit

The Zheltorechenskoye uranium deposit at Zholtye Vody is located in the northern Krivoi Rog iron district in the Dnepropetrovsk Province (Figure 1). It is one of four known uranium districts in the western USSR. All known uranium mineralization in the Krivoi Rog district is associated with the Iron Formation. Two deposits have been mined. The Pervomaiskoye deposit at Terny was mined out by 1969 using open pit techniques. The deposit at Zholtye Vody, discovered later than Terny, is now being mined by underground methods.

Discovery and Development

Rich iron ores were discovered in the Krivbas (the Krivoi Rog Basin) in 1781. Later exploration indicated high-grade mineralization (46 percent to 70 percent Fe) in an area two to seven kilometers (km) wide and more than 100 km long. The first commercial recovery operation began in 1875, and the district developed rapidly into one of the largest iron-producing areas in the world. More than 80 percent of the iron produced in the USSR comes from the Krivbas.

When uranium was first discovered in the Krivbas is uncertain; however, the Zholtye Vody deposit was discovered in 1946. Uranium mineralization is known to occur in the Iron Formation as irregular lenticular and stratiform bodies in an area nine km long and 0.5 to 2.0 km wide. The Iron Formation hosting the uranium was discovered in 1895 and mined by open pit methods from 1898 through 1933, and by underground methods from then until uranium was encountered in the iron ore. Development of the uranium deposit began in 1949 or 1950, initial production began in 1951, and the Novaya mine has operated since then.

The mine is developed to a depth of 1,475 meters. Downward drilling from that level indicates continuous ore reserves exist at least 100 meters deeper, so it is likely that mining depths eventually will increase.

Ore Reserve and Recovery Rate

The initial ore reserve estimate of the Zholtye Vody deposit has not been released. However, Nuexco estimates unmined reserves at 15 to 20 million pounds U_3O_8. The ore occurs in multi-bodies at different elevations throughout the mine. Stratigraphy, lithology and structure controlled the placement of orebodies. Orebody dimensions vary greatly by length, thickness and vertical extent. The bodies tend to parallel the controlling structure or cut diagonally across it where influenced by fracturing and faulting. Stratiform deposits, which parallel the structure, are the largest and most important; breccia and vein-filled bodies may parallel the structure, but more commonly are diagonal to it. Nuexco estimates the in-place ore grade of remaining ore reserves at 0.12 to 0.15 percent U_3O_8. However, it is common to encounter zones of high-grade ore that may exceed 1.00 percent U_3O_8.

Uranium concentrate is produced at a mill near Zholtye Vody. Its design capacity is approximately 500,000 metric tons of ore per year. Based on reported mill capacity and other factors, Nuexco estimates remaining mine life at 10 to 15 years. Production during the early years amounted to approximately 700 metric tons of uranium (MTU) annually; today, it probably is less due to ore grade. The mill also processed ore from the Terny mine until it closed in 1969.

Mineralization

The chief uranium ore minerals in the deposit are pitchblende and uraninite. Other minerals less common in occurrence but important to total uranium production are brannerite, coffenite and uranium silicates of the nenud-

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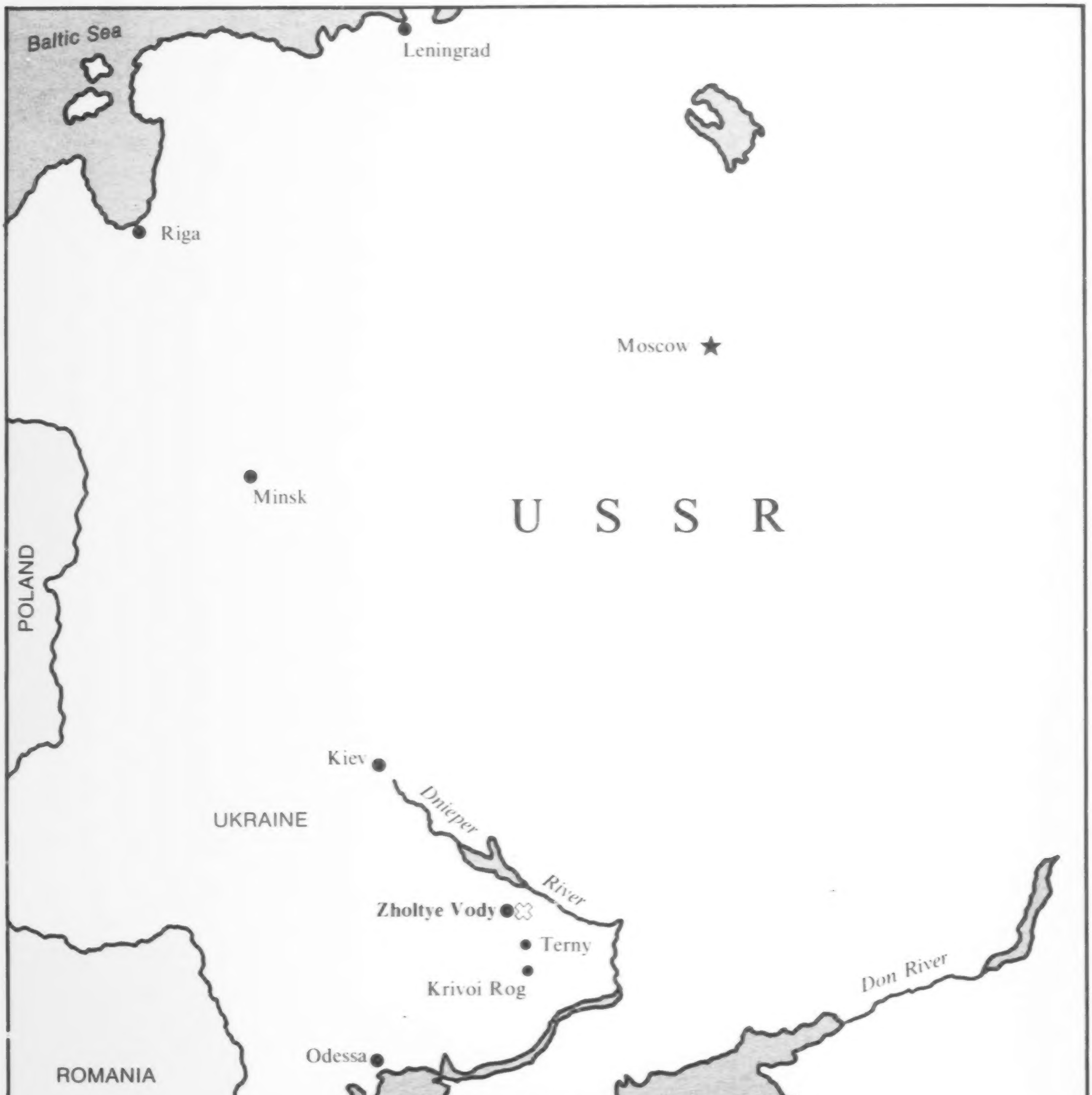
Figure 1

WESTERN U.S.S.R.


Baltic Sea
Leningrad
Riga
Moscow
Minsk
U S S R
POLAND
Kiev
Dnieper River
UKRAINE
Zholtye Vody
Terny
Krivoi Rog
Don River
Odessa
ROMANIA
Sea of Azov
Black Sea
Bucharest
Novaya Uranium Mine

kevite group (calcium-magnesium silicates with trace rare earths in which the uranium content varies from 20 percent to 55 percent). Uranium mineralization is associated with complex hypogene metamorphosed rock and related hydrothermal alteration. The iron ore formations of Lower Proterozoic are closely related to younger uranium mineralization. The relationship is compounded by complex metasomatism (a replacement process) in ferro-carbonate rocks and intensely altered albitites, magnetite, commingtonite-biotite and quartzite schist.

Uraninite, pitchblende and brannerite show concentration in the albitites; the minerals also formed as small clusters in the magnetites and commingtonites. The main minerals in the ferro-carbonates and quartzite schists are uraninite and pitchblende, which developed as veins in fractures and along structural zones. Coffenite and uraninite are common as fissure filling material in the carbonate rock, where it is closely associated with miscellaneous ferrous and sulfide mineralization.

Multi-staged metasomatism complicated the mineralizing process. As a result of granitic intrusions and regional structural deformation, repeated rock alteration and zonal development of the mineral suite are common, especially in fractures, breccia zones and along structural planes. The source of uranium mineralization is older conglomerates and arkoses[1] underlying the iron ore-bearing formations. The uranium content of the older rocks is known to be abnormally high throughout the northern part of the Krivbas. The movement of uranium into the Iron Formation is due to remobilization during metasomatic processes.

Geology

Situated in the central part of the Ukrainian crystalline shield, the Krivbas is characterized by Archean and Proterozoic crystalline rocks overlain by Cenozoic formations. The Archean comprises a series of granitic and metamorphic rocks that developed approximately 3500 to 2800 million years ago. The Proterozoic series consists of highly metamorphosed rocks such as gneiss, schist, metasandstone and metaconglomerate, dolomite and ferruginous silicate rocks. The age of the Proterozoic series is approximately 2700 to 1800 million years. (The age of the uranium mineralization is approximately 1700 to 900 million years.)

The iron ore-bearing sequence is represented by the highly metamorphosed Krivorozhskaya formation sequence of Lower Proterozoic age. The Krivorozhskaya is broken down into an Upper, Middle and Lower sequence which in turn is subdivided into five formations. These formations are described as follows:

1. **Upper Series**—The Gleevatskaya Formation, composed of metasandstone, biotite schists and dolomites. The formation contains low-grade iron ore.
2. **Middle Series**—The Gdantsevskaya Formation, consisting of quartz-mica/chlorite, graphite schist, metasandstone, carbonates and ferruginous quartzites. Important high-grade iron and uranium deposits occur at the contact with the Gleevatskaya series.
3. The Saksaganskaya Formation, made up of 14 alternating units of ferruginous quartzites and schists. The ferruginous rock includes banded magnetite, hermatite-silicate, albitites and martite. It contains uranium in addition to the largest percentage of high-grade iron ore formations in the Krivbas. It is in unconformable contact with the underlying formation.
4. **Lower Series**—The Skelevatskaya Formation, composed of carbonate talc, metasandstone, arkoses, schists and metaconglomerate in the lower part. It is in unconformable contact with the underlying formation.
5. The basal unit, or Novokrivorozhskaya Formation, made up of quartz-biotite schists, metasandstones, quartzites and tuffaceous shales. It is in unconformable contact with Archean rocks.

The metamorphic rocks of the Krivorozhskaya series form a very complex fold structure striking northwest-southeast. The general structure is called the Krivoi Rog synclinorium, consisting of a broad syncline with complex internal synclinal and anticlinal folding. The western limb of the synclinorium has been cut off by thrust faulting and the main iron ore sequence remains well below the surface. The east limb is displaced by faulting, but retains the original continuity and can be found at or near the surface throughout portions of the strike length of the main structure.

The Zholtye Vody deposit is confined to a narrow isoclinal syncline, the east and west limbs of which are almost vertical. The rock formations of the central portion belong to the Krivorozhskaya series. Figure 2 is a generalized vertical section of the ore-bearing structure. The syncline is broken into large blocks by faulting parallel to the strike and diagonally across it. Metasomatic products of rock and ore forming stages characterize each block. The structural position and nature of uranium orebodies were controlled primarily by metasomatism and recrystallization.

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[1] Ya. N. Belevtsev, et al., 1981.

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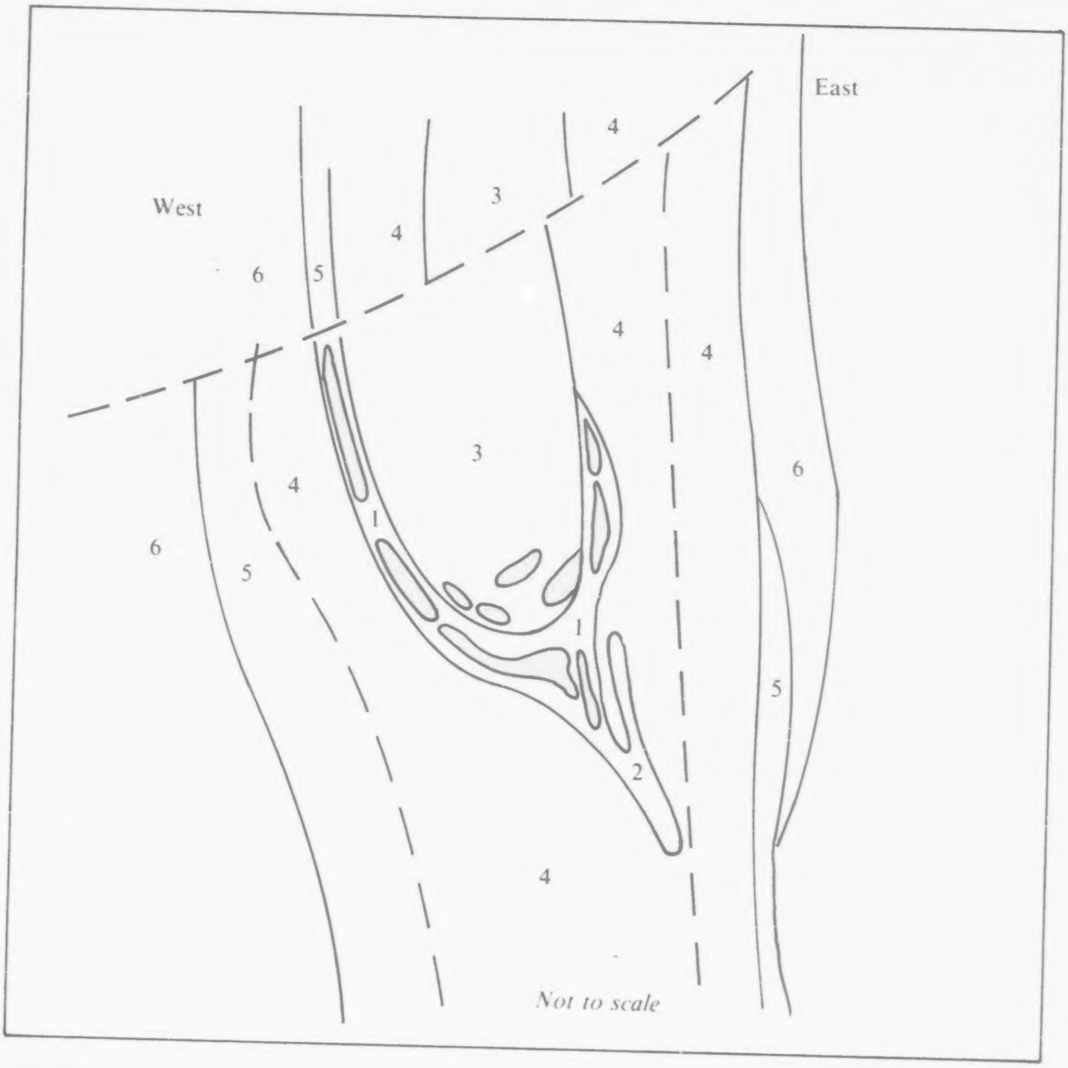

- 🟉 = Uranium ore
- 1 = Albitites
- 2 = Iron ore
- 3 = Upper Krivorozhskaya Series
- 4 = Middle Krovorozhskaya Series
- 5 = Lower Krovorozhskaya Series
- 6 = Archean granites
- \ = Fault

Figure 2. Generalized vertical section through the Krivoi Rog synclinorium of the Zholtye Vody uranium deposit showing the structural relationship of uranium ore bodies.

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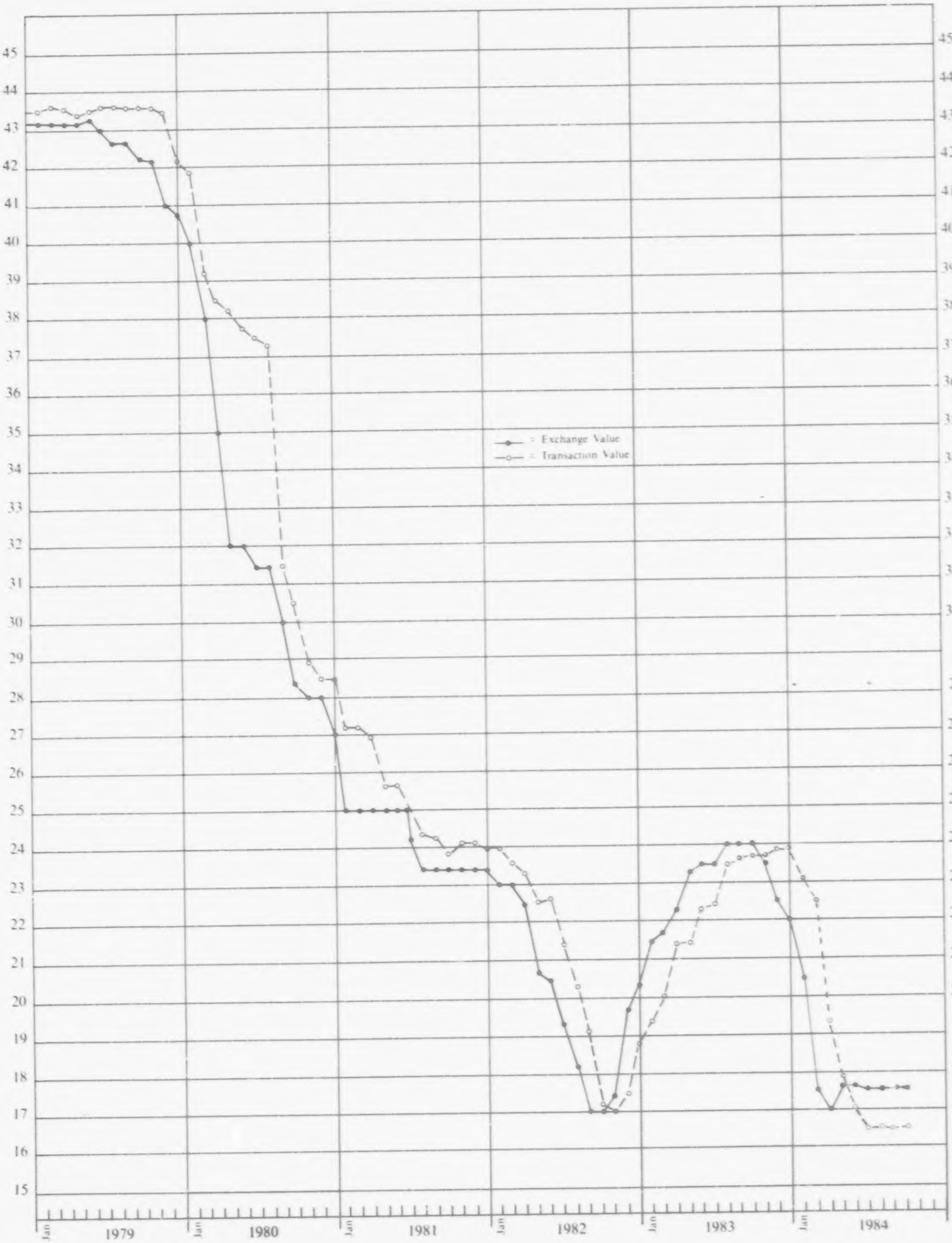
EXCHANGE AND TRANSACTION VALUES SINCE JANUARY 1979

Determined as of the last day of the month indicated



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HISTORICAL MARKET DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	32.50	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00
1984	20.50	17.50	17.00	17.75	17.75	17.50	17.50	17.50	**17.50**			

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85
1984	23.05	22.50	19.25	17.90	17.00	16.50	16.60	16.40	**16.55**			

HISTORICAL CONVERSION VALUES

Determined as of the last day of the month indicated (US Dollars/lb. U as UF_6)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60
1984	0.60	0.30	0.80	0.80	0.80	0.00	0.00	0.80	**1.00**			

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AUSTRALIA

	Price Index of Materials Used in Manufacturing Industry—All Groups[1] (1969=100)	Award Rates of Pay Indexes Australia—Adult Males In Mining Wage Earners, Weekly Rates[2] (1976=100)
1983 Avg.	401.2	181.8
Jun 1983	415.6	181.0
Jul 1983	408.3	180.7
Aug 1983	403.0	180.7
Sep 1983	402.9	180.6
Oct 1983	397.5	188.3
Nov 1983	395.5	188.3
Dec 1983	399.2	188.1
Jan 1984	399.1	188.3
Feb 1984	402.4	188.2
Mar 1984	403.8	188.0
Apr 1984	404.1	195.8R
May 1984	403.7R	196.6R
Jun 1984	404.8	196.6P
Jul 1984	408.3	—

P = Preliminary R = Revised since last month

CANADA

	Industry Selling Price Index: Manufacturing[1] (1971=100)	Wage-earner Data: Average Hourly Earnings (C$)[2]					
		Uranium Mines (SIC 057)	Metal Mines (SIC 051-059)	Mines, Quarries and Oil Wells[3] (SIC 051-099)	Primary Metal Industries Non-ferrous[4]		Chemicals and Chemical Products[5] (SIC 372-379)
					(SIC 296)	(SIC 298)	
1983 Avg.	298.8	—	14.69	14.30	—	—	11.17
Jul 1983	300.4	16.48	14.35	13.93	11.70	9.83	11.04
Aug 1983	301.3	16.93	14.36	13.89	11.82	10.08	11.19
Sep 1983	301.1	17.66	14.90	14.41	11.99	10.32	11.29
Oct 1983	301.6	17.73	15.27	14.65	11.76	10.03	11.30
Nov 1983	301.8	17.82	15.29	14.67	11.78	10.62	11.38
Dec 1983	302.9	17.84	15.11	14.66	11.86	10.60	11.51
Jan 1984	305.4	17.74	15.27	14.74	11.91	10.84	11.69
Feb 1984	306.6	17.78	15.59	14.90	12.04	10.82	11.51
Mar 1984	308.7	18.05	15.52	14.82	12.14	10.84	11.58
Apr 1984	310.5R	18.06	15.83	15.10	11.96	10.34	11.63
May 1984	310.6R	18.48	15.64	15.06	12.11	10.16	11.65
Jun 1984	311.0R	18.08R	15.48R	14.80R	12.38R	10.40R	11.66R
Jul 1984	312.5R	17.43P	15.42P	14.85P	12.52P	10.18P	11.78P
Aug 1984	312.2P	—	—	—	—	—	—

P = Preliminary R = Revised since last month

For annual averages prior to 1983, and for notes pertaining to these statistics, see pages 23-26 of Report 190 of June 1984.

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GOVERNMENT STATISTICS

REPUBLIC OF SOUTH AFRICA

	Average Declared Working Costs per per Metric Ton of Gold Ore Milled (Rand)[1]	Tonnage-Weighted Index of Average Working Costs per Metric Ton of Gold Ore Milled (March 1982=100)[2]	Consumer Price Index[3] (1975=100)[4]	Producer Price Index All Groups[5] (1975=100)	Total Employment in Mining and Quarrying (Code 35)[6]	Total Salaries and Wages in Mining and Quarrying (1,000 Rand) (Code 40)[6]
1983 Avg.	51.87	115.0	262.2	274.8	696,579	3,644,772
Jul 1983	—	—	262.5	273.7	704,202	314,566
Aug 1983	—	—	265.6	278.9	698,984	311,789
Sep 1983	52.92	117.4	267.3	279.4	696,435	312,264
Oct 1983	—	—	270.0	281.0	693,225	311,418
Nov 1983	—	—	271.4	281.6	688,459	317,485
Dec 1983	53.70	119.6	273.2	283.7	690,750	333,595
Jan 1984	—	—	274.7	283.3	689,807	326,619
Feb 1984	—	—	278.4	286.5	702,553	335,906
Mar 1984	55.30	123.1	281.9	288.0	715,628	342,332
Apr 1984	—	—	286.1	290.2	712,963	327,550
May 1984	—	—	288.3	292.6	710,040	327,937
Jun 1984	56.95	126.2	291.2	295.3R	717,009	347,121
Jul 1984	—	—	295.1	296.0	—	—
Aug 1984	—	—	297.0	—	—	—

UNITED STATES

	Producer Price Index[1]		Consumer Price Index[2] (1967=100)	GNP Implicit Price Deflator[3] (1972=100)	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]			
	Industrial Commodities (1967=100)	All Commodities (1967=100)			Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1983 Avg.	315.8	303.1	298.4	215.63	12.57	13.43	10.59	8.65
Jun 1983	315.3	302.4	298.1	214.55	12.55	13.37	10.52	8.63
Jul 1983	316.5	303.2	299.3	—	12.59	13.56	10.59	8.67
Aug 1983	317.3	304.7	300.3	—	12.54	13.46	10.62	8.62
Sep 1983	317.1	305.3	301.8	216.44	12.62	13.46	10.70	8.73
Oct 1983	318.5	306.0	302.6	—	12.67	13.55	10.79	8.71
Nov 1983	318.3	305.5	303.1	—	12.64	13.56	10.86	8.77
Dec 1983	318.4	306.1	303.5	218.53	12.75	13.33	10.90	8.84
Jan 1984	319.1	308.0	305.2	—	12.67	13.38	10.91	8.88
Feb 1984	320.6	308.9	306.6	—	12.81	13.34	10.90	8.86
Mar 1984	321.9	311.0	307.3	220.58	12.85	13.33	10.95	8.88
Apr 1984	322.5	311.4	308.8	—	12.91R	13.30R	10.97	8.89
May 1984	323.3	311.7	309.7	—	12.99	13.37	11.02	8.89
Jun 1984	323.9	311.4	310.7	222.40R	12.96R	13.40R	11.03R	8.91
Jul 1984	324.0	312.0	311.7	—	13.05P	13.36P	11.10R	8.95R
Aug 1984	323.5	310.9	313.0	—	—	—	11.10P	8.99P

P = Preliminary   R = Revised since last month

For annual averages prior to 1983, and for notes pertaining to these statistics, see pages 23-26 of Report 190 of June 1984.

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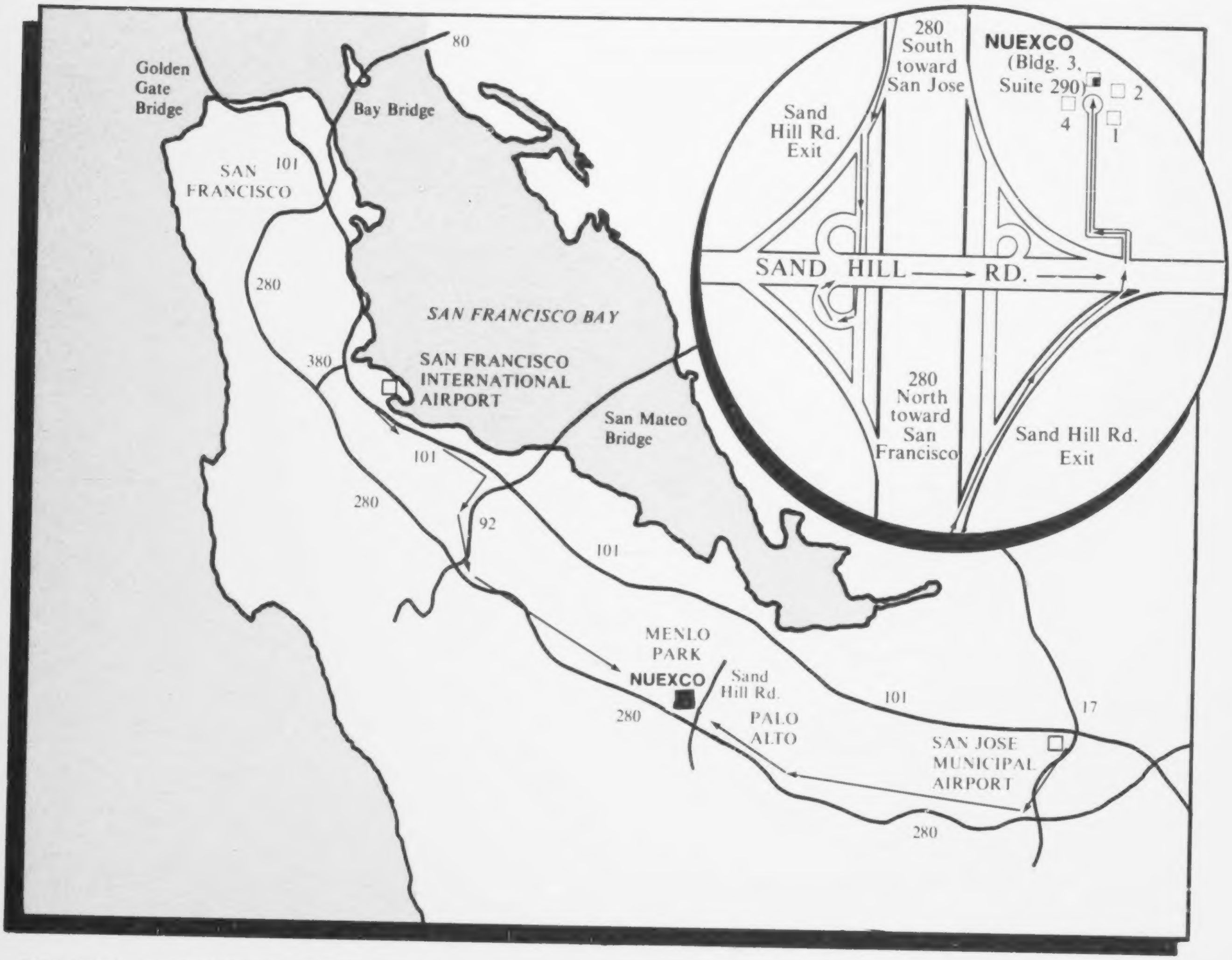
Golden Gate Bridge
80
Bay Bridge
SAN FRANCISCO
101
280
SAN FRANCISCO BAY
380
SAN FRANCISCO INTERNATIONAL AIRPORT
San Mateo Bridge
101
280
92
101
MENLO PARK
NUEXCO
Sand Hill Rd.
280
PALO ALTO
101
17
SAN JOSE MUNICIPAL AIRPORT
280
280 South toward San Jose
NUEXCO (Bldg. 3, Suite 290)
2
4
1
Sand Hill Rd. Exit
SAND HILL RD.
280 North toward San Francisco
Sand Hill Rd. Exit

DIRECTIONS TO NUEXCO'S CORPORATE OFFICES

From San Francisco Airport:
1. Take U.S. 101 south towards San Jose.
2. Continue on U.S. 101 seven miles to Route 92 exit.
3. Take Route 92 west towards Half Moon Bay.
4. Continue on Route 92 five miles to Interstate 280 exit.
5. Take Interstate 280 south towards San Jose.
6. Continue on Interstate 280 ten miles to Sand Hill Road exit.
7. Take Sand Hill Road east towards Menlo Park (go under Sand Hill Road overpass, circle 270° to cross Interstate 80 on overpass heading east).
8. Turn left at first traffic light.
9. After turning left, take second left and follow signs for 3000 Sand Hill Road.
10. We are in Building 3, Suite 290, on the second floor.

From San Jose Airport:
1. Take Highway 17 south towards Santa Cruz.
2. Continue on Highway 17 five miles to Interstate 280 exit.
3. Take Interstate 280 north towards San Francisco.
4. Continue on Interstate 280 six miles to Sand Hill Road exit.
5. Take Sand Hill Road exit.
6. Proceed through both sets of traffic lights.
7. Take first left after second traffic light and follow signs for 3000 Sand Hill Road.
8. We are in Building 3, Suite 290, on the second floor.

Note: Distances are approximate.

HOTELS

Hilton Inn, San Francisco Airport, (415) 589-0770.
Hyatt House, 1740 North 1st Street, San Jose, (408) 298-0300
Holiday Inn-Palo Alto, 625 El Camino Real, Palo Alto, (415) 328-2800
Rickey's Hyatt House, 4219 El Camino Real, Palo Alto, (415) 493-8000
Fairmont Hotel, 950 Mason Street, San Francisco, (415) 772-5000

RESTAURANTS

L'Auberge, 2826 El Camino Real, Redwood City, (415) 365-3735 or (415) 365-9623
Dal Baffo European Cuisine, 878 Santa Cruz Avenue, Menlo Park, (415) 325-1588
Velvet Turtle, 325 Sharon Park Drive, Menlo Park, (415) 854-3813
Ming's of Palo Alto (Chinese), 1700 Embarcadero Road, Palo Alto, (415) 327-0771
Hugo's Market Restaurant (at Hyatt), 4219 El Camino Real, Palo Alto, (415) 493-8000

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*Independent contractors representing Nuexco

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EXECUTIVE SUMMARY
REPORT 194
(All data as of September 30, 1984)

Exchange Value $17.50, unchanged	The **Exchange Value** is **$17.50** per pound U_3O_8, unchanged since last month. Four recent uranium sales are reported, involving a total of two million pounds U_3O_8 equivalent. One was a sale of natural UF_6; two involved deliveries prior to 1986, and also met the conditions for inclusion in the Transaction Value.
Supply-Demand Ratio rose to 5.8:1.	Active spot and near-term **uranium supply** amounts to **5.5 million** pounds U_3O_8 equivalent, up 0.4 million pounds since last month. Active spot and near-term **uranium demand** totals **955 thousand** pounds, down 95 thousand pounds. The spot and near-term **supply-demand ratio** rose to **5.8:1.**
Transaction Value rose $0.15, to $16.55	The **Transaction Value** is **$16.55** per pound U_3O_8, up $0.15 since last month. The calculation includes 12 transactions involving a total of 4.3 million pounds U_3O_8 and equivalent UF_6, and covers a period of 5 months.
Loan Use Charge Rate unchanged at 6%	The **Loan Use Charge Rate** remains **6 percent** per annum in an almost dormant market.
Conversion Value rose to $1.00	The **Conversion Value** is **$1.00** per pound U as UF_6, up from $0.80 last month. No secondary market conversion transactions are reported. Active secondary market supply of conversion services for delivery within three years totals 2.8 million pounds U as UF_6. No active demand is reported.
SWU Values $115 for DOE-origin (FY85) $20 discount for FY86 $90 for non-DOE origin (delivery within 15 months) $98 for calendar year 1986	The **SWU Values** are **$115** per SWU of DOE origin and FY85 delivery, at 0.3 tails, and **$20** per SWU discount from DOE price for FY86 delivery (at 0.3 tails). SWU Values for non-DOE origin are **$90** per SWU for delivery within 15 months, and **$98** per SWU for calendar year 1986. No secondary market transactions are reported. Active secondary market SWU supply amounts to 275 thousand SWUs, while active demand totals 395 thousand SWUs.
Focus	Japan's nuclear industry is expanding its fuel fabrication facilities in an effort to achieve complete domestic capability.
Australia	The status of contracts with Electricite de France is uncertain as a result of Australia's ban of uranium exports to France.
Japan	The Ministry of International Trade and Industry Advisory Committee recently confirmed previous goals for nuclear generating capabilities into the late 1990s.
Switzerland	Two antinuclear referendums were defeated by public vote.
United States	Westinghouse paid Intercontinental Energy Corporation to take title to the Lamprecht uranium mine (in situ leach) in Texas.
Raw Materials	The Novaya uranium mine in Western USSR is associated with one of the world's largest iron-producing regions.

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NUEXCO REPORT 194 FIGURES OF THE MONTH (Sepember 30, 1984)	This Month (Report 194)	Last Month (Report 193)	12 Months Ago (Report 182)
Exchange Value[1]	17.50	17.50	24.00
Transaction Value[1]	16.55	16.40	23.65
Loan Use Charge Rate[2]	6%	6%	6%
Conversion Value[3]	1.00	0.80	1.00
Near-Term Uranium Supply[4]	5.5	5.1	7.2
Near-Term Uranium Demand[5]	0.96	1.1	4.4
Near-Term Supply-Demand Ratio	5.8	4.6	1.7
Recent Uranium Sales:			
Number of Transactions[6]	4	4	2
Quantity of Material[7]	2.0	1.0	0.1-0.35
Nuexco SWU Values:[8]			
DOE origin, FY85 delivery, 0.3 tails assay	115	100	
DOE origin, FY86 delivery, 0.3 tails assay	20[9]	—	
non-DOE origin, delivery within 15 months	90	85	
non-DOE origin, delivery for calendar year 1986	98	—	
USDOE SWU Prices:			
USEC	135.00	135.00	
AFC	153.00[10]	153.00[10]	138.65
Requirements	157.00[10]	157.00[10]	149.85
Market Value of Enriched UF_6[11, 12]:			
2.5 w/o U_{235}	587	537	583
3.0 w/o U_{235}	758	691	743
3.5 w/o U_{235}	932	848	906
4.0 w/o U_{235}	1,109	1,008	1,072

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[1] US $ per pound U_3O_8 equivalent.

[2] Per annum.

[3] US $ per pound U as UF_6.

[4] Active inquiries to sell, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[5] Active inquiries to purchase, for delivery within 12 months after contract signing (millions of pounds U_3O_8).

[6] Uranium sales only; does not include loans, conversion, or SWU transactions.

[7] Millions of pounds U_3O_8, equivalent.

[8] US $ per SWU.

[9] Discount from USEC price on delivery.

[10] Effective 10/1/84.

[11] Calculated using the Nuexco Exchange Value, Conversion Value, and 0.20 percent tails assay. From 2/28/83 through 9/30/83, calculations used the Nuexco SWU Value for the relevant fiscal year. From 10/31/83 through 2/29/84, calculations used the Nuexco SWU Value for DOE origin and FY84 delivery. As of 3/31/84, calculations use the Nuexco SWU Value for DOE origin and FY85 delivery.

[12] US $ per KgU as UF_6, rounded to the nearest $.

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URANIUM THROUGH THE LOOKING GLASS

By

George White, Jr.
President
Nuexco

Presented to:

Atomic Industrial Forum Uranium Seminar

Keystone, Colorado
October 2, 1984

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URANIUM THROUGH THE LOOKING GLASS

By

George White, Jr.
President, Nuexco

A year ago spot uranium prices were about $24 per pound U_3O_8 and had been rising since late 1982. The prevailing mood was generally upbeat. Some of you thought me unduly bearish for saying, during last year's Santa Fe meeting, that I found it difficult to develop a convincing case for any substantial or sustainable price recovery while production continued to exceed consumption and large inventories were held in weak hands.

Being a devotee of the theory of contrary opinion, I also noted:

"As the consensus grows concerning the likely occurrence of some future event, so does my suspicion that the event in question will not occur."

While I had then anticipated lower prices, I assigned a very low probability to any penetration of the $20 level. In fact, spot prices made an intra-month low of $16 per pound U_3O_8 in March of this year and have yet to recover to the $20 level.

My point is this. Prices won't move up (or down) even one penny because you or I believe that higher (or lower) prices would be beneficial or detrimental to one party or another. The market doesn't care one bit about what is right or wrong, good or bad, healthy or unhealthy, smart or stupid. The market is what it is. Hence my title, for as you know, viewing things through a mirror reverses them. I have the distinct impression that we have spent far too much time in front of the mirror—talking and worrying about how things ought to be rather than how things really are.

In this context, it is my view that in late 1983 and early 1984, we witnessed certain events that have fundamentally and perhaps permanently changed the uranium market. In order of importance, these events were: the issuance of U.S. Enrichment Contract, the Cigar Lake announcement, and, finally, what I refer to as the Zimmer episode. Each was significant, but coming as they did, one on top of the other, their cumulative impact was enormous. Taking them one at a time:

The new enrichment contract proposed by DOE in January 1984 marked the end of an era when uranium demand was driven by the feed delivery requirements of enrichment contracts, and the return to a situation where uranium demand is a function of reactor consumption.

The over-expansion of the uranium production industry was the result of a series of miscalculations. The utility industry miscalculated capacity needs and its ability to finance the plants ordered. AEC, ERDA and DOE, in turn, repeatedly miscalculated future growth of nuclear power. Their overly optimistic forecasts indicated a SWU shortage and led to changes in enrichment contracting policy. Uranium producers responded to these forecasts and the expressed needs of utilities by increasing production as fast as possible and planning still further expansion. With perfect hindsight, it is fair to observe what we missed some pretty clear warning signals. As the delays and cost overruns became apparent, the basic financial integrity of many utilities was seriously threatened. Secondly, it should have been clear that the large and continuously growing divergence between uranium consumption and feed demand associated with enrichment contracts was an anomaly that could not continue indefinitely.

The USEC allows utilities to supply uranium in quantities and on schedules that match actual needs as opposed to meeting pre-set, necessarily optimistic SWU schedules. This reduces and defers the amount of uranium that will be needed by those utilities that held AFC contracts. Uranium inventories will be drawn down more slowly, and new uranium purchases will be deferred. Similar effects will result from the provisions allowing utilities to work off inventories of enriched product and the provisions which allow purchases of non-DOE SWU and non-DOE enriched product. In a speech delivered last month at the Uranium Institute, Dick Andersen of our staff quantified this reduced demand at 118 million pounds U_3O_8 over the period through 1991.

While it had to happen eventually, the USEC, from a uranium producer's viewpoint, can only be described as a near and intermediate term disaster. It may be argued that, longer term, the effects will be beneficial—the consequence of a rationalized producer sector, but the situation is painful today.

The second event was the announcement of the Cigar Lake deposit. The formal announcement of a new uranium find would hardly have been so momentous, but for the facts. Size—125 million pounds (since increased to 230 million pounds and still open); Grade—10 percent; Location—in Saskatchewan right on trend with Key Lake and other high-grade deposits; and, Timing—December 1983.

So, just at the time that the USEC was announced with its implications of reduced and deferred uranium demand, the largest and richest deposit in history was an-

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nounced. For me, Cigar Lake has conclusively demonstrated that Saskatchewan has fully emerged as the Saudi Arabia of the uranium business. I am not a geologist, but have little doubt that Key Lake and Cigar Lake are but the tip of a large, yellow iceberg.

With demand reduced and delayed, and persuasive evidence that uranium is not only abundantly available, but abundantly available at low cost, one can understand the ennui with which utilities greet producer warnings about the dire consequences of continued low prices.

The final thread in this fabric is the Zimmer episode. I refer, of course, to the decision by Cincinnati Gas & Electric to scrap its essentially complete nuclear unit. This announcement came in January 1984 hard on the heels of the USEC and Cigar Lake. And Zimmer has been followed by other cancellations and near cancellations including Marble Hill, Midland, Seabrook and Shoreham. Zimmer's fuel, about 2.5 million pounds U_3O_8 equivalent, was liquidated back into the market, some as U_3O_8, some as UF_6 and the balance through defabrication. All this material reduces unfilled future requirements and delays the date that new supplies are needed from primary producers. Additional liquidations are merely a question of time.

So we have the following situation. Demand has been reduced as a consequence of both a new enrichment contract and reactor cancellations. Production continues to exceed consumption, the more so as reactors are canceled, causing inventories to grow and further increasing carrying costs. Inventory liquidation by utilities wishing to rationalize their individual situations runs headlong into competition from a variety of sources, including, (a) primary producers willing or forced to sell to maintain cash flow, (b) newly non-nuclear utilities which need cash and are prepared to dump uranium at almost any price and (c) sellers of enriched product. The impact is obvious and immediate—price weakness. Under the circumstances, it is difficult to see how higher prices are possible until the market clears. A more likely scenario would involve a continuation of the pattern evident during the past two years, including the erratic movements associated with abrupt decisions to buy and sell. In the longer term, hopes for substantial price increases face the reality of Cigar Lake.

In referring to Cigar Lake I intend to be both specific and general for I see that deposit as representative of a class of deposits which, by their size and grade, dwarf what we have previously come to view as normal. Indeed, who would have dared, five years ago, to predict the discovery of a 230 million pound deposit, grading 10 percent? Likewise, who of you would be so bold as to suggest, today, that Cigar Lake is one of a kind?

Actually the history of uranium exploration argues the reverse. Contrary to experience in oil and gas and many minerals where the shallower, richer, lower-cost material was found and exploited first, uranium started with lower grades and higher costs and appeared to be proceeding in the opposite direction. Thus, any suggestion that Cigar Lake is a one of a kind deposit is likely in error. It is certainly contrary to recent experience and could well risk the trap of intellectual as well as geologic arrogance.

Where then does all this leave us?

The facts appear to be these:

1. The USEC has reduced and deferred uranium demand.

2. New, large, high-grade uranium deposits are waiting in the wings.

3. Plant cancellations have released and will continue to release large quantities of uranium into the spot and near-term markets. How much? I would view 10 million pounds over the next three years as a minimum.

4. During the four-year period 1980–1983 when prices were declining or weak, free world uranium production exceeded consumption by more than 130 million pounds U_3O_8. And during 1984, Nuexco believes that production will be approximately 25 million pounds in excess of consumption, bringing 5-year total additions of inventory to nearly 160 million pounds U_3O_8.

5. Inventories as of year end 1984 are estimated at 470 million pounds. This 470 million pound figure excludes DOE-owned material and other non-commercial stocks held by other governments. Put another way, if all uranium production halted on December 31, 1984, we could rely on inventory alone and not *have* to restart the mills until 1990.

Assuming these facts represent reality, what are the market implications, both near and longer term? First and foremost, I would repeat an old Wall Street admonition—"Don't fight the tape." As noted before, whether or not we like it, the market is what it is. If you have a deposit with production costs of $80 per pound U_3O_8, you are *not* in the uranium business—regardless of how much you would like to think you are.

The uranium market has become a commodities market. Spot and near-term prices reflect current supply/demand forces, and, as such, have no relationship to the prices necessary to sustain reasonable rates of return for uranium investment over the long term.

Nuexco's Exchange Value is generally viewed in the industry as describing the spot or near-term market. The

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long-discussed concept of a definable, recognized "long-term price" or "contract price" presents some very diffi-term price" or "contract price" presents some very different and difficult problems. Presumably such a long-term price would, in order to be considered fair or appropriate, cover full cost of production and reasonable profit. But the exercise becomes meaningless when one tries to compare 3-pound rock in Wyoming with 50-pound rock at Key Lake and 200-pound rock at Cigar Lake. One could just as well ask, "What is a fair price for oil?" Saudi Arabia may have production costs of $1.00 per barrel. Deep oil in Wyoming's Overthrust Belt may cost $15 or $20 per barrel. A fair price for the Saudis would choke off most US production. A fair price for Wyoming oil would provide the Saudis with substantial economic rewards—even obscene profits. Likewise, a fair price for Wyoming uranium would be a bonanza for the high-grade Canadian producers.

The facts suggest that the commodity aspects of uranium will become more important and more dominant before they become less so. This may not be welcome news to producers and particularly those producers who presently have uncommitted production or whose present contracts are due to expire in the next few years. It is my judgment that even some of the larger, non-US producers whose long-term client relationships have supported negotiated market prices well above today's spot levels will find their customers increasingly insistent on reducing or eliminating the negotiated premium over nearer-term prices.

Any sustainable upward movement of spot prices in real terms must await market clearing. Some has taken place. We have seen some utilities acquire excess inventory in lieu of conventional long-term contracts. Much more will have to occur. Redistribution of inventories will not, however, handle the problem alone. Production and consumption must be brought into balance. So long as production exceeds consumption by 33% and inventories continue to increase, it is difficult to make a case for higher prices.

I would close with one final caution. The moment I sense that the majority of you are *really* beginning to agree with these views, I will be looking very carefully for reasons that I should again reverse my position. Contrarians like to see things in reverse—as through a looking glass.

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